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# RAILWAY ENGINEERING
**and Maintenance of Way**

PUBLISHED BY THE

BRUCE V. CRANDALL COMPANY, CHICAGO

**Office of Publication, Room 501 The Plymouth Building, 305 Dearborn Street, Chicago**

TELEPHONES - - { HARRISON 3357 / AUTOMATIC 7357

**Eastern Office: Room 714, 132 Nassau Street, New York City**

A Monthly Railway Journal

Devoted to the interests of railway engineering, maintenance of way, bridges and buildings.

Communications on any topic suitable to our columns are solicited.

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Vol. I. CHICAGO, APRIL, 1905. No. 1.

**The Editorial and Business Offices of the Railway Engineering will be located after May 1st in the Security Building, corner Madison Street and Fifth Avenue, Chicago.**


## *"Volume One Number One"*

THE many difficulties which attend the issue of the first number of a new paper make it well nigh impossible that it should fully represent the intentions of the projectors. Those to whom it is addressed naturally look at the first number as an index of the future. But journalism is a growth; perfection in it never can be reached; but constant improvement is always to be expected. This paper is offered now as an idea, which is to be worked up. That it has merit and is capable of great development we are thoroughly assured. Its purpose is very well indicated in its name. Its field is not as broad as that of most technical journals, but it is broad enough to warrant the production of an excellent paper and to furnish support for it. The RAILWAY ENGINEERING AND MAINTENANCE OF WAY has already met with encouragement enough to take it out of the realm of experiment and to justify the unusual claim that it was an assured success before the issue of the first number.

Practically all of the space in this initial issue is of a necessity given over to a report of the recent convention in Chicago of the American Railway Engineering and Maintenance of Way Association, and future issues will of course deal largely with the problems that interest that branch of railroading.

Among all the standard railway publications there is none devoted exclusively to the engineering department, while for many years there have been a number published in the interest of the mechanical department. The realization that this branch of railroading which has to do with maintenance of way, track, bridges and buildings is not only as important, but on some accounts more important than the mechanical department, has been largely responsible for the starting of a new publication of a monthly journal devoted exclusively to the engineering department.

Everything in railroading relating to this department will receive the most thorough treatment editorially, all important articles being illustrated in the most complete manner. In addition to the original editorial matter, a brief summary of everything published anywhere will be given in a railway engineering index.

Probably the fact that we publish the Railway Master Mechanic, which is the leading railway mechanical paper, will be sufficient guarantee that the same high grade journal will be maintained in the engineering field.

## *The Maintenance of Way Convention*

The American Railway Engineering and Maintenance of Way Association opened its annual convention at the Auditorium, Chicago, on March 21. This organization, embracing as it does the brightest minds in railway engineering, has long since passed the point in its career when its deliberations are regarded as of the highest value to the maintenance of the properties which they represent, and the work of the meeting just passed will go on record as having been surpassed for results by no previous session. The words of President McDonald, Chief Engineer of the Louisville & Nashville, rang true as showing the lively and aggressive spirit animating this body, when he said in effect that the time had now arrived when the Association could reap the harvest of benefits accruing from their past excellent work.

The reports presented at this, the sixth annual meeting, went into the questions of wooden bridges and trestles, standard roadbed plans, steel rails, and the other important work the Association had laid out to do, in the thorough manner which has always characterized its work. In no case was there room for adverse criticism, even from the most rigid point of view, and those phases of the matters with which they are always prepared to do battle, will go on record as having been dealt with by experts whose opinions are not to be gainsaid.

In the consideration of the first report, as was to be seen in its framing, there was a total absence of ambiguity in the treatment of first principles. The clause referring to bents in bridges and trestles took cognizance of the fact that wooden structures will always remain an important part of the internal economy of a railroad, and with that understanding, safe formulae were prepared for practical use, first presenting the reasons therefor, by a plain elucidation of the forces producing the stresses which the formulas provided for.

A most vital consideration of standard unit stresses was embodied in another report on the same subject,

and the recommendations made with the object in view of designing of the numbers of bridges and trestles, were formulated to cover all conditions for long-leaf yellow pine and Oregon fir. These recommendations deserve, and no doubt will have, a large influence in future practice.

The specifications for bridge timber were the most rigid, perhaps, of any yet presented, and in the light of other practice might be termed stiff in the fullest sense of the word, but if followed in the spirit of the report there will be no reason to fear for the safety of structures in which such material enters.

Under the head of roadway it is easy to detect more than one master hand, and the authors of that report may rest in the serene consciousness of having formulated a practice that embodies in the several groups, the best in the art of roadbed work. In the section of the report that referred to methods of grade reduction there was not presented any data on the practical phases of work in connection therewith, but it is under advisement to make a special report later. The conclusions of the roadbed report were to the effect that there should be recognized three widths, and these should be selected to suit the possible density of traffic to be handled in the future. It is plain that the report is based on the prospective necessities of the future, and no matter what disposition is made of it, or what the action of individual roads in the premises, the committee is on record for plenty of room on roadways, and, therefore, on the safe side for any increase in width of rolling stock.

There was no regular report of the committee on rails, which is unfortunate in view of the fact that there is no question of livelier import today than that of steel rails, it being well understood that some definite action is necessary to stem the tide of breaking rails under our heavy trains. Letters from the members, however, headed by that of the chairman of the committee and others, contained information that let in some light on the bearing that chemistry and the speed of rolling of the rail, has on its failure to carry the loads now imposed, and also its resistance to wear, the latter consideration having long dominated all others. It is now evident that immunity from rupture is of prime importance, and how to obtain it is one of those things that involves, not only a revision of chemical elements, but of heat and physical treatment. Drop tests should be conclusive in demonstrating the ability of a rail to resist shocks, but loopholes exist even there, which permits jockeying within certain limits, and such tests are shorn of their value when test pieces are taken from a selected portion of the ingot. The interest taken in this matter by the Association is scarcely second to that evinced by the railway officials of the country as a whole, and will result in a decrease of the wholesale breakage now going on.

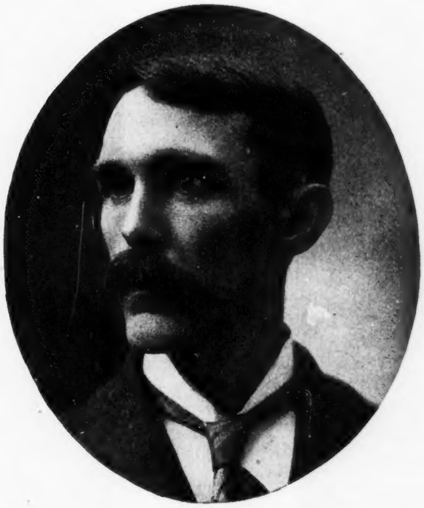
There is more care evinced in the specifications of steel bridges, and in their mathematics, than usual, and it is patent that the bridge engineer has a grasp on the theory and practice of his profession, that seems not to leave much more for improvement. The formula laid down, which expresses the intent of the committee for loads in bridge design, are clean cut, and based on what has been found good in practice. A close attention to the minutest details for steel structures is the prevailing feature of its work.

Yards and terminals have of late received much attention, and the newest idea in yard lay-outs to receive the approval of those interested, is the hump or gravity yard. Such yards have been highly successful in the classification and distribution of cars into trains, and their installation on trunk lines has worked to remarkable advantage for the easement of congestion in dense traffic. The development of the gravity system hsa been brought up to its present state of efficiency by reason of the closest attention to the amount of elevation and rates of grades required with different kinds of cars, and also climatic conditions, and with the understanding that traffic conditions govern in the choice between the gravity yard and ordinary switching or poling yard.

The subject of concrete, plain and reinforced, has now become one of the most interesting features of railway engineering, and that report to the Association is, therefore, one that will attract more than passing attention, more particularly for the reason that it is the joint work of a committee composed of representatives from the American Society of Civil Engineers; the Society for Testing of Materials; the Railway Engineering and Maintenance of Way Association, and the Association of Portland Cement Manufacturers. With an array of talent like the above, and the prestige of their several organizations as a foundation on which to rear their work, the results obtained will be of the greatest moment in future engineering operations. The extension experiments, to actually determine stresses in concrete, plain and armored, as well as the actual work already recorded in construction, and under way in fields little thought of until recently, warrants the prediction that it will rapidly place steel and stone among obsolete materials for engineering purposes.

In signalling, block or interlocking, the well known devices for safeguarding travel have attained a perfection little short of marvelous, but the real test of a safety device remained to be demonstrated in the electric service of the subway in New York City, by which a train is automatically stopped, the operation being entirely out of the hands of the train crew.

Water services and water purification has also received at the hands of the association an impetus never known before for the reason that previous investigations have been profited by, and erroneous premises are too well known now to be repeated. The work done in this direction has been the result of original thought, that will be of the greatest value to roads afflicted with bad water. In its entirety the work of this meeting will leave its mark on maintenance of way details.



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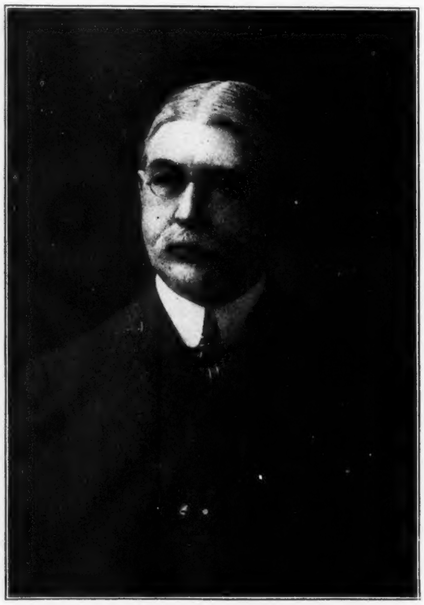

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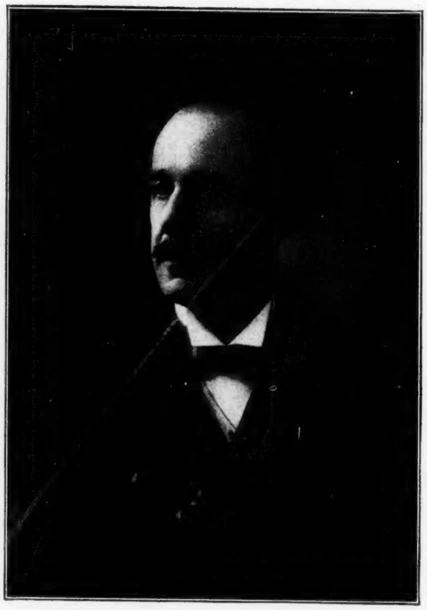

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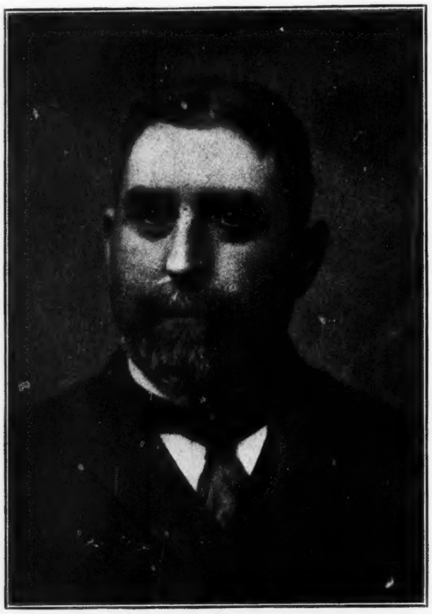

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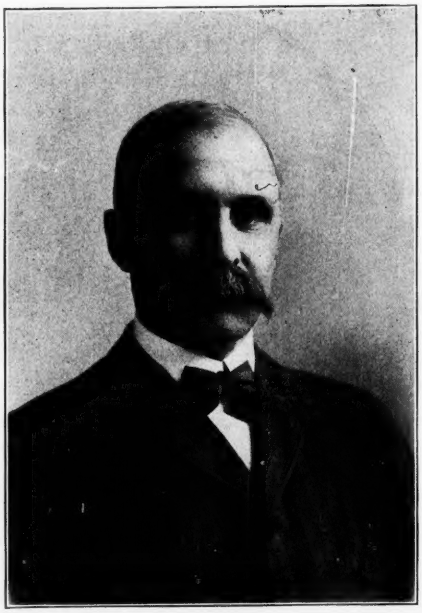

W. S. DAWLEY, TREASURER, 1904-1905.

# *Sixth Annual Meeting of the Railway Engineering and Maintenance of Way Association*

THE American Railway Engineering and Maintenance of Way Association held their sixth annual convention at the Auditorium, Chicago, March 21, 22 and 23, 1905. The officers for 1904-1905 were:

President, Hunter McDonald, chief engineer, Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn.

First Vice-President, H. G. Kelley, chief engineer, Minneapolis & St. Louis and Iowa Central Railways, Minneapolis, Minn.

Second Vice-President, James Dun, chief engineer, Atchison, Topeka & Santa Fe Railway system, Chicago, Ill.

Treasurer, W. S. Dawley, engineer maintenance of way, Chicago & Eastern Illinois Railroad, Chicago, Ill.

Secretary, L. C. Fritch, assistant to the general manager, Illinois Central Railroad, Chicago, Ill. E. H. Fritch, assistant secretary.

DIRECTORS.

F. H. McGuigan, fourth vice-president, Grand Trunk Railway System, Montreal, Canada.

A. W. Johnston, general superintendent, New York, Chicago & St. Louis Railway, Cleveland, O.

A. W. Sullivan, general manager, Missouri Pacific Railway System, St. Louis, Mo.

Walter G. Berg, chief engineer, Lehigh Valley Railroad, New York, N. Y.

W. L. Breckinridge, engineer, Lines East of Missouri river, C., B. & Q. R. R., Chicago, Ill.

W. C. Cushing, chief engineer maintenance of way, S. W. System, Pennsylvania Lines, Pittsburg, Pa.

The program was arranged as follows:

FIRST DAY—MARCH 21.

President's address.
Reports of secretary and treasurer.
Reports of standing committees.

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| VII. Wooden Bridges and Trestles | Bulletins | 48-61 |
| I. Roadway | Bulletins | 48-58 |
| XV. Iron and Steel Structures | Bulletins | 54-61 |
| X. Signaling and Interlocking | Bulletin | 57 |
| XIV. Yards and Terminals | Bulletin | 58 |
| XIII. Water Service | Bulletin | 58 |

Evening session, 7:30 p. m. to 10:00 p. m.

SECOND DAY—MARCH 22.

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| XI. Records, Reports and Accounts | Bulletins | 59-61 |
| VI. Buildings | Bulletin | 59 |
| VIII. Masonry | Bulletin | 59 |
| XII. Uniform Rules | Bulletin | 59 |
| II. Ballasting | Bulletin | 60 |
| V. Track | Bulletin | 60 |

Annual dinner at 7:00 p. m.

THIRD DAY—MARCH 23.

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| III. Ties | Bulletin 60 |
| IV. Rail | Progress report |
| IX. Signs, Fences and Cattle Guards | Progress report |
| XVI. Economics of Ry. Location | Progress report |
| Special. Classification of Track | Progress report |

New business.
Election of officers.
Adjournment.

The president's address referred to many important matters to be taken up by the association and a strong appeal was made to the members to give a portion of their time and thought during the coming year to the preparation of papers and discussions of reports, so that the "Bulletin" might be made a useful and readable publication. The question of the practice in the past to avoid all discussion of devices and appliances which are proprietary articles or covered by patents was referred to and Mr. McDonald advocated the condemning of the unworthy and the commending of the meritorious. Nearly all the important improvements of railway appliances in recent years have been the result of the labors of men not connected directly with the railroads. The word "Standard" was defined as being that which stands for the best we know how to do. What it represents may and will change from year to year, but the name will remain the same.

The secretary's report showed receipts during the year to the amount of $10,327.35, and expenditures of $6,673.77, with cash on hand amounting to $8,559.91. This balance, together with bills receivable to an amount exceeding $5,000, shows that the financial condition of the association is satisfactory. The membership at the date of the convention last year was 437, and 57 new members have joined during the year. The society has lost by withdrawals and members dropped for non-payment of dues 28 members, and three have died, leaving a net membership at the time of this convention of 463.

WOODEN BRIDGES AND TRESTLES.

The first committee report was on wooden bridges and trestles. The chairman stated that this was the first time the committee had ever reported to the convention and that although many roads were trying to do away with wooden bridges and trestles, they would necessarily be in use for some time to come. Prof. H. S. Jacoby, of Cornell University, reported on the bibliography relating to this subject, and invited members to furnish him with such information as they might have.

The committee submitted a plan for a ballasted deck trestle without dimensions, as local conditions and varying unit stresses would determine many of the sizes and details, but the type shown was recommended as best keeping in mind the fact that repairs must be made in time. Treated timber to be used throughout.

Most of the time was consumed in discussing definitions, and the committee's work was revised in many instances. A lively discussion ensued over the suggestion by Mr. J. B. Berry that wood packing blocks were out of date and the word wood should be stricken out. Finally a motion was made to strike out the definition of "packing block," but was lost. Then an amendment offered by Mr. Berry to strike out the words "usually wood" was put to a vote and lost. After the discussion on definitions was concluded, specifications for bridge timbers were taken up and the afternoon session was given up to this subject, with the result that the specifications were referred back to the committee, with instruct-

tions to condense them into less space and more convenient form. The following is abstracted from the report of the committee on wooden bridges and trestles:

DEFINITIONS.

Wooden Trestle.—A structure composed of upright members, supporting simple horizontal members or beams, the whole forming a support for loads applied to the horizontal members.

Frame Trestle.—A structure in which the upright members or supports are framed timbers.

Pile Trestle.—A structure in which the upright members or supports are piles.

Bent.—The group of members forming a single vertical support of a trestle, designated as pile bent where the principal members are piles, and as framed bent where of framed timbers.

Posts.—The vertical and battered members of the bent of a framed trestle.

Piles.—Timbers driven in the ground and intended generally to support a structure.

Batter.—The deviation from the vertical in upright members of a bent.

Cap.—The horizontal member upon the tops of piles or posts connecting them in the form of a bent.

Sill.—The lower horizontal member of a framed bent.

Sub-Sills.—Timbers bedded in the ground to support framed bents.

Intermediate Sill.—A horizontal member in the plane of the bent between the cap and sill and to which the posts are framed.

Sway Braces.—Members bolted or spiked to the bent and extending diagonally across its face.

Longitudinal Struts or Girts.—Stiff members running horizontally or nearly so from bent to bent.

Longitudinal X Braces.—Members extending diagonally from bent to bent in vertical or battered planes.

Sash Braces.—Horizontal members secured to the posts or piles of a bent.

Stringers.—The longitudinal members extending from bent to bent and supporting the ties.

Jack Stringers.—A single line of stringers placed outside of the main stringers.

Ties.—Transverse timbers resting on the stringers and supporting the rails.

Guard Rails.—Longitudinal members, either iron or wood, secured on top of ties.

Packing Blocks.—Small members, usually wood, used to secure the parts of a composite member in their proper relative positions.

Packing Spools or Separators.—Small castings used in connection with packing bolts to secure the several parts of a composite member in their proper relative position.

Drift Bolt.—A piece of round or square iron driven through one member of a structure into another to connect them or point driven as a spike.

Dowel.—An iron or wooden pin placed between two members, but not through them, to connect them.

Shim.—A piece of wood or metal placed between two members of a structure to bring them to a desired position.

Fish Plate.—The short piece lapping a joint secured to the side of several members which are butt jointed.

Bulkhead.—Timber placed on edge against the side of an end bent for the purpose of retaining the embankment.

BIBLIOGRAPHY.

A list of books and pamphlets relating to wooden bridges and trestles, with short notes showing what part of the subject is referred to in each work, is given herewith:

Chanute, Octave, and George S. Morrison, "Kansas City Bridge." New York, 1870. The bridge of which plans and descriptions are given has combination trusses of the double intersection Warren type.

Charles river; "An account of some of the bridges over Charles river, as connected with the growth of Cambridge." Cambridge, 1858.

Cooper, Theodore: "American Railroad Bridges," New York, 1890. Eleven of the 23 plates give general plans, and in some cases details of wooden truss bridges. The text contains brief notes on a number of the earliest bridges built in this country.

Dredge, James; "The Pennsylvania Railroad: Its Organization, Construction and Management," London and New York, 1879. Brief notes on the wooden bridge over the Delaware river at Trenton, built by Lewis Wernwag, in 1803, and replaced in 1875.

Duggan, George; "Specimens of the Stone, Iron and Wooden Bridges, Viaducts, Tunnels, Culverts, etc., of the United States Railroads," New York, 1850. Descriptions and plans of the wooden truss bridges of the Burr type and of pile and framed trestles on the Utica & Syracuse Railroad; the Cascade arch bridge; the viaduct across Canewacta creek and other bridges on the New York & Erie Railroad; one on the Northern Railroad of New York; three truss bridges on the Connecticut River Railroad, and one of the type used on the Baltimore & Ohio Railroad. Most of these illustrations were republished in London in 1863 by John Weale in "Theory, Practice and Architecture of Bridges of Stone, Iron, Timber and Wire," in five volumes.

Comolli, L.; "Aut. Les Ponts De L'Amerique du Nord, Edude, Calcul, Description de ces Ponts. Comparison des Systemes Americain et Europeen," Paris, 1879. One volume text and one volume plates. Five of the plates show plans and details of a Howe truss of 14 panels; a combination Pratt truss by the American Bridge Company of Chicago; a combination Post truss; a combination truss by Kellogg & Maurice, which is a modified Pratt truss in which the lower chord is supported midway between panel points by additional diagonals; a combination Fink truss over Tygart's Valley at Grafton, Va., on the Baltimore & Ohio Railroad; and a short wooden beam bridge on the Philadelphia & Reading Railway.

Foster, Wolcott C.; "Treatise on Wooden Trestle Bridges According to the Present Practice onAmerican Railroads," New York, 1891. The text is illustrated by 37 plates showing details of pile and framed trestles; increased to 45 plates in the edition of 1894.

Haupt, Herman: "General Theory of Bridge Construction," New York, 1851. Besides historical notes on the relative extent to which the Town lattice, Burr and Long trusses are used on railroads, the second part gives dimensions, material, weight and cost for six wooden truss bridges on the Pennsylvania Railroad, one on the Cumberland Valley Railroad, one on the Philadelphia & Reading Railway, and one on the Baltimore & Ohio Railroad.

Johnson, J. B., C. W. Bryan and F. E. Turneaure; "Theory and Practice of Modern Framed Structures," New York, 1893. Historical development of the truss idea, detail plans of a standard Howe truss bridge on the Chicago, Milwaukee & St. Paul Railway and of one on the Southern Pacific Railway. Several plans of pile and framed trestles of modern design.

Long, Stephen H.; "Description of S. H. Long's Bridge," together with a series of directions to bridge builders, Philadelphia, 1848.

Macdonald, Charles; "Discussion of the General Principles Involved in the Construction and Action of the Isometrical Truss Bridge," Philadelphia, 1867. The plate shows the plan of the Schuylkill river bridge on the Perkiomen Railroad, which has combination trusses of the double intersection Warren type.

Mahan, D. H.; "Treatise on Civil Engineering." Revised and edited, with additions and new plates, by De Volson Wood.

Contains description and some details of the Long, Town, Howe, Burr, Prott, McCallum and Post trusses.

Merriman, Mansfield, and Henry S. Jacoby; "Text Book on Roofs and Bridges." Part I, Stresses in Simple Trusses. Sixth edition, New York, 1905, Part III, Bridge design, New York, 1894. Historical notes on the evolution of American truss bridges.

Pontzen, Ernest: "Ueber Holzerne Brucken unter besonderm Hinweise auf Amerikanische Gerust Brucken" (Trestle Bridges), Wein 1876. The plate shows the three different types of trestle bents of the Louisville, Cincinnati & Lexington Railroad, the Philadelphia & Reading Railway, and the Central Pacific Railroad.

Pope, Thomas; "Treatise on Bridge Architecture," no place, 1811. Brief descriptions or notes, without illustrations, on a number of the earliest wooden bridges in America.

Post, S. S.; "Treatise on the Principles of Civil Engineering as Applied to the Construction of Wooden Bridges," New York, 1859.

Tower, G. B. N.; "Instructions on Modern American Bridge Building," Boston, 1874. Contains a plate showing a few forms of trestle bents of one story.

Town, Ithiel; "Some Account and Description of Ithiel Town's Improvement on the Construction and Practical Execution of Bridges, Aqueducts and Railroad Bridges," New York, 1831. Gives a list of Town truss bridges built in the United States.

United States War Department: "Reports of the Chief of Engineers of the United States Army." These reports contain data relating to bridges crossing navigable streams.

United States War Department Report on Bridging the Mississippi river between St. Paul, Minn., and St. Louis, Mo., by Brevet Major-General G. K. Warren, Corps of Engineers, United States Army, Washington, 1878. Gives data relating to six wooden and combination bridges on the Upper Mississippi river.

United States Interior Department; "Report of the Patent Office," Washington. Records of patents granted relating to wooden truss bridges.

Vose, George L.; "Manual for Railroad Engineers and Engineering Students," New York, 1873. Brief descriptions and plans, with details of a Howe truss and of seven combination trusses of the Howe, Pratt, Warren and Fink type.

Whipple, Squire; "Essay on Bridge Building," Utica, 1847. Work on bridge buildings, Utica, 1847. "Elementary and Practical Treatise on Bridge Building," New York, 1872. These works are noted as containing the first important development of the theory of bridge stresses and design of simple truss bridges. The plan shows a few short span Howe trusses and a wooden truss, with double intersection Warren bracing.

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"Combination Bridge Building on the Pacific Coast," by Alfred D. Ottewell. Trans. Am. Soc. C. E., Vol. 27, page 446, 1892.

"The Mississippi River Bridges." Historical and descriptive sketch of the bridges over the Mississippi river, by F. B. Maltby. Journal Western Society of Engineers, Vol. 8, page 418, August, 1903. Describes seven wooden and combination bridges completed between 1856 and 1882.

"Some Early Engineering Works in Pennsylvania." Presidential address by Edwin F. Smith. Proceedings Engineers' Club of Philadelphia, Vol. 21, page 73, April, 1904. Refers to a report made in 1838, which comments upon the experimental design of lattice bridges on the Little Schuylkill & Susquehanna Railroad (now the Catawissa branch of the Philadelphia & Reading Railway), and of their wooden trestle towers ranging from 53 to 129 feet in height. The plans of one truss span and a 122-foot tower of the Long Hollow Crossing, built in 1840, are reproduced. This was the first high trestle tower built in the United States. The experimental model is preserved in the Museum of the Franklin Institute in Philadelphia. Engineering Record.

Journal of the Franklin Institute.

Van Nostrand's Engineering Magazine.

Engineering News.

Railroad Gazette.

Engineering Record.

Engineering (London.)

These periodicals contain many historical notes on wooden bridges in America, and many articles describing individual bridges, with more or less details.

I. O. Walker, assistant engineer, N. C. & St. L. Ry., Paducah, Ky. (chairman); F. E. Schall, bridge engineer, Lehigh Valley Railroad, South Bethlehem, Pa., vice-chairman; F. H. Bainbridge, principal engineer, C. & N. W. Railway, Chicago; D. B. Dunn, division engineer, Seaboard Air Line, Atlanta, Ga.; H. G. Fleming, president and chief engineer, Memphis Belt Railway, Memphis, Tenn.; B. W. Guppy, bridge engineer, Maine Central Railroad, Portland, Me.; J. C. Haugh, resident engineer, N. O. & N. E. R. R., New Orleans, La.; H. S. Jacoby, professor of bridge engineering, Cornell University, Ithaca, N. Y.; C. C. Mallard, assistant superintendent, L. & W. R. R., Lafayette, La.; A. S. Markley, division engineer, C. & E. I, R. R., Danville, Ill.; F. C. Miller, resident engineer, Southern Pacific Co., Sacramento, Cal.; F. J. Stimson, engineer maintenance of way, Grand Rapids & Indiana Railway, Grand Rapids, Mich., and Job Tuthill, bridge engineer, PereMarquette Ry., Detroit, Mich., committee.

### ROADWAY.

Specifications for the formation of roadway in which changes were introduced as a result of the discussion are given below in revised form, the paragraph numbers being retained:

19. Loose Rock shall comprise all detached masses of rock or stone of more than one cubic foot and less than one cubic yard, and all other rock which can be properly removed by pick and bar and without blasting; although steam shovel may be used or blasting may be resorted to on favorable occasions in order to facilitate the work.

37. In crossing bogs or swamps of unsound bottom, a special substructure of logs and brushwood may be required, the logs forming this foundation to be not less than six (6) inches in diameter at the small end. If necessary there shall be two or more layers crossing each other at right angles, the logs of each layer being placed close together, with broken joints and covered closely with brush; the bottom layer shall be placed transversely to the roadway and project at least five (5) feet beyond the slope stakes of the embankment.

48-A. Unless otherwise specified, the contract prices per cubic yard cover any haul found necessary, and there will be no allowance made for any so-termed "overhaul."

56-A. At designated intervals niches or recesses for the protection and convenience of the railway employees shall be provided.

60. The contractor must arrange his work so that there will be no interference or delay in any manner with the train service of the company, and he will be responsible for any damage to the company's property caused by his acts or those of his employees. Whenever the work is liable to affect the

movement or safety of trains, the method of doing such work must first be submitted for approval, without which it shall not be commenced or prosecuted. If continuous detention occur to the train service the company reserves the right to complete the work at the expense of the contractor after giving him written notice.

65. Wherever it is necessary for material of any description to be transported across the existing track or tracks, the location of the crossings must be approved. The material and labor of placing and maintaining the same will be furnished by the company and the actual cost charged to the contractor and deducted from his estimate.

67. The cost of installment, maintenance and operation of all signals necessary to ensure the safety of trains, consequent upon the contractor's work, shall be borne by the contractor, and all instructions regarding their observance shall be strictly obeyed by him.

68. Previous to or during the work of grading, the contractor, if directed, shall erect and maintain temporary fences in order to prevent trespass upon the railway or damage to adjoining property.

81. In the foregoing specifications it is understood and agreed that the chief engineer of the ............ Company is in charge of the work, and he may appoint such assistants as he may select. Whenever the specifications refer to the judgment, direction, decision, approvai, etc., of an employee of the .............. company, they designate and mean that the chief engineer or one of his assistants is intended and referred to. The decision of the chief engineer shall be final as to the intent and meaning of these specifications.

In reference to Section 60, the discussion resulted in elimination of a provision for a penalty to be paid by the contractor for delay to trains. It was thought that the possibility of damage was hedged about by so many other requirements that this provision is unnecessary. Mr. Berg, of the Lehigh Valley R. R., and Mr. Berry, Union Pacific R. R., spoke of the practice of using flagmen, appointed by the railway company and paid for by the contractors, for the protection of trains past localities where contract work in progress is liable to obstruct main track. Mr. Kelley, of the Minneapolis & St. Louis Ry., protects trains under such circumstances with block signals. The operators stationed at the ends of these blocks are paid for by the contractors. The conclusions of this committee were finally changed to read as follows:

### Conclusions.

First—There should be recognized three widths of roadbed, for standard-gage railway, and these should be selected to suit the probable density of traffic to be handled in the future. These widths should be 14, 16 and 20 feet.

Second—A width of 13 feet between center lines of main tracks is recommended.

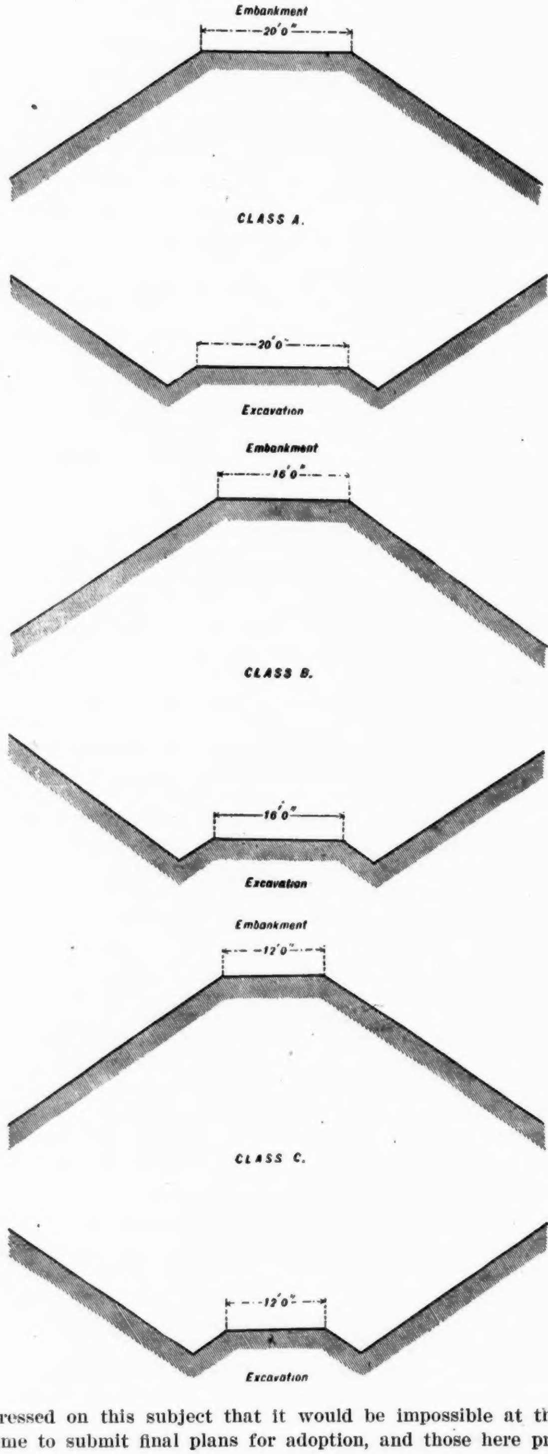
Third—Rock excavations should be taken out not less than 6 inches below the subgrade.

Fourth—No wasting should be allowed closer than 10 feet from slope stakes.

### Standard Roadbed Plans.

From a report of the Committee on Roadway:

Your committee has been requested to submit plans for standard cross sections of roadbed, and would respectfully call attention to the fact that while the association has expressed itself "That on first-class roads of standard gauge, with constant and heavy traffic, a minimum permanent width of 20 feet at sub-grade is good practice," yet the association has, since said conclusions was adopted, appointed a committee to submit plans for three classes of railroads, and we therefore have deemed it expedient to submit three standards. It will be noted that these plans do not show any details, such omissions being intentional, for the purpose of bringing out the views of the members of the association. In fact, it is believed that there will be so many different views ex-




pressed on this subject that it would be impossible at this time to submit final plans for adoption, and those here presented are to be considered of a preliminary nature for the purpose of being discussed and referred back to the committee with instructions from which final plans may be prepared.

There was a good deal of discussion on the question

of width of Class "C" roadbed, the committee having first recommended a width of 12 ft. It was pointed out by several members that roadbeds constructed 12 ft. wide cannot be maintained to that width on embankments without refilling, owing to the shrinkage and washing down by rains, and the convention therefore voted to make this dimension 14 ft. There was also a spirited discussion on the question of the width between centers of main tracks. The committee had recommended a width of 4 ft., but it was shown that a number of roads, including the New York Central & Hudson River R. R., the Baltimore & Ohio R. R., the Grand Trunk Ry., and others, have been successfully operating for many years on a width of 12 ft. between track centers, and after the expression of such opinion the convention voted to compromise this measurement to 13 ft.

RAIL.

The report of this committee was a progress report, no formal report being presented. The basis of the discussion consisted of communications from William R. Webster, chairman, and Thomas H. Johnson, extracts from Robert W. Hunt's paper in the Journal of the Franklin Institute for May, 1899, and a paper by F. L. Moister. The chairman stated that the committee wished to get from the members an expression as to their experience with the breakages of rails irrespective of specifications of the association or not. It appeared from the discussion of this subject that the Baltimore & Ohio was the only road that had made any attempt at enforcing the specifications. The letter of Mr. Thomas H. Johnson, consulting engineer of the Pennsylvania Lines West, on the heat treatment of steel in rail manufacture, brought out the information that rails which formerly required eight minutes were now rolled to a finish in two minutes.

A proposition was advanced to modify the height of drop for rails of 75-lb., 85-lb. and 100-lb. sections. The height of drop now required by the standard specifications of the association for these three sections respectively, is 18 ft., 20 ft. and 22 ft. The chairman of the committee and representatives of the rail manufacturers present, intimated that these heights were too severe, so much so that test pieces from rails rolled from the top of the ingot could not withstand the shock. The third clause of the standard specifications provided that "the test piece shall preferably be taken from the top of the ingot." It was proposed that if the association was disposed to reduce the heights of drop from 18 ft., 20 ft. and 22 ft., to 17 ft., 18 ft. and 19 ft., respectively, for the rail sections stated, it would be agreeable to the manufacturers to see these specifications changed to omit the word "preferably," so as to make it obligatory to take the test piece from the top of the ingot. The question was put to vote and it was not only decided to retain the present specifications in reference to height of drop, but also to strike out the word "preferably," thereby making it mandatory that the test piece shall be taken from the top of the ingot. The advantage of compromising the height of drop in order that the brittle metal from the top of the ingot would show fewer breakages under the drop was not seen by the membership. One member called attention to the fact that the height of drop, as it stood in these specifications three years ago, was considered unreasonably small, and the increase of these heights to 18, 20 and 22 ft. was then considered to be a compromise rather than a stand for the theoretical requirements. Other information brought out in this discussion is given in connection with some comments in the editorial columns of the Railway and Engineering Review of March 25, and as being a very timely article in connection with this subject, we quote it in full herewith:

"In our issue of last week we called attention to the excessive breakage of rails in track during the past winter, showing that rails rolled of late, at more than one mill, have been greatly lacking in toughness. The proceedings of the American Railway Engineering and Maintenance of Way Association, in Chicago, this week, have abundantly verified our statement of the trouble and diagnosis of the cause, and an account of the discussion of the report of the rail committee makes interesting reading. This account we give elsewhere in this issue, reserving, however, for these columns the points which bear most pertinently in the direction of our comments of last week.

"In this discussion a number of members, some of whom are eminent engineers, expressed it as their opinion that rail metal has been growing worse from year to year, particularly since the years 1899 or 1900. One of the managers of a large railway system stated that as many as 123 rails laid during the past season had broken under trains within a short time this winter, and in two cases broken rails have caused expensive damage in freight-train wrecks. These broken rails comprised about 15 per cent of the whole number laid. Representatives of two other large railway systems spoke of great trouble with piped rails breaking under heavy traffic, and in particular instances the character of the break had shown extremely brittle material for rail steel. The trend of the discussion was to the effect that rails have been breaking at an alarming rate, and it is now high time that some improvement in manufacture must be enforced upon the mill men.

"The situation with respect to inferior quality of the metal is somewhat different from that of a few years ago. Then the principal agitation was for harder material in the rails, which would stand the wear of the traffic better, whereas it now seems that the question is not only the old one of improved wearing quality, but also the more serious one of avoiding danger to traffic. Unless the quality of the metal be improved it would not be long before tracks would be laid pretty largely with rails of doubtful strength. Of course no such contingency as this can be contemplated, and it is incumbent upon the manufacturers to improve the quality of the metal.

"It seems to be pretty generally admitted by both sides that this improvement of the metal can be brought about by cropping a larger portion of the metal from the top of the ingot. It is now common practice to discard about 18 per cent, or less, of the material in this manner, but if a considerable larger proportion of the spongy material from the top of the ingot can be eliminated from the rails a superior product will undoubtedly result. Of course such a change the manufacturers will adopt with hesitancy, as it materially reduces the profits of the rolling, but it would seem that such a course must inevitably follow from motives of economy, even on the part of the manufacturers, who are usually required to make good the rails which break in the track. The purchasers of rails have become thoroughly aroused to the

situation, if not alarmed, and it is now quite likely that important changes in rail manufacture or processes will have to be adopted without much delay."

### IRON AND STEEL STRUCTURES.

This committee submitted its last year's report with a number of changes, which we give herewith in the changed form:

#### Iron and Steel Structures.

From the report on this submitted and adopted at recent Maintenance of Way convention.

#### GENERAL SPECIFICATIONS FOR STEEL RAILROAD BRIDGES.—1905.

#### I. General Features.

1. The material in the superstructures, except rivets, and as otherwise designated, shall be structural steel.

2. On a straight line, the clear height of through bridges shall not be less than 21 ft. above top of rails for a width of 6 ft. over a single track, and the clear width shall not be less than 7 ft. from the center line of the track between the heights of 4 and 17 ft. above the rails. The width shall be increased to provide the same minimum clearance on curves, for a car 80 ft. long, and 59 ft. center to center of trucks, allowance being made for curvature and superelevation of rails.

3. The width center to center of trusses shall in no case be less than one-twentieth of the effective span.

4. Ends of deck plate girders and track stringers of skew bridges at abutments shall be square to the track.

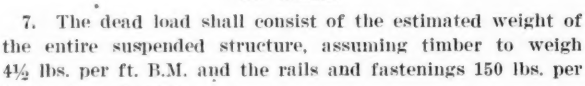
5. Wooden tie floors, where used shall be proportioned to carry the maximum wheel load, with 100 per cent impact, distributed over three ties; fiber strain on ties not to exceed 2,000 lbs. per sq. in., and the length to be not less than the total distance over the outer edge of supports plus 12 ins. They shall be spaced with no more than 6-in. openings, and shall be notched to a tight fit over supporting girders, depth of notch to be not more than $1\frac{1}{2}$ ins.

6. Guard timbers shall be not less than 5x8 ins. laid with the 8-in. face down, notched over each tie and securely fastened.

#### II. Loads.

7. The dead load shall consist of the estimated weight of the entire suspended structure, assuming timber to weigh $4\frac{1}{2}$ lbs. per ft. B.M. and the rails and fastenings 150 lbs. per linear foot of track.

8. The moving load shall consist of two consolidation engines followed by a train load, according to Cooper's series, or a uniform system of loading practically equivalent to the same. The minimum loading to be according to the following diagrams:



9. Heavier loading shall be proportional to the above on the same spacing.

10. The dynamic increment of the moving load shall be added to the maximum computed live-load strains and shall be determined by the formula

$$I = S \frac{300}{L + 300}$$

where

I = impact to be added to the live-load strains.

S = calculated maximum live-load strain.

L = loaded length of track in feet producing maximum strain in members.

11. Truss spans shall have their lateral systems designed for a force of 600 lbs. per linear foot of the loaded chord; and 200 lbs. per linear foot of the unloaded chord. Girder bridges shall have the lateral system at the loaded chord designed for a force of 600 lbs. per linear foot, these forces being considered as moving.

12. On viaduct towers provision shall be made for a wind force of 50 lbs. per sq. ft. on $1\frac{1}{2}$ times the vertical projection of the structure unloaded; or 30 lbs. per sq. ft. on the same surface plus 12 ft. for height of train when the structure is fully loaded, or when loaded on either track with empty cars assumed to weigh 900 lbs. per linear foot.

13. Provision shall be made in structures for a longitudinal force, applied at the rail, or 2-10 of the moving load.

14. Provision shall be made on curves for the centrifugal forces produced by the full live load, running at a speed to be determined by the engineer for each case, acting at a height of 5 ft. above the rails.

#### III. Unit Strains and Proportion of Parts.

15. All parts of structures shall be so proportioned that the sum of the maximum strains shall not exceed the following amounts in pounds per sq. in., except as modified in paragraphs 21 to 24:

16. Axial tension on net section....................16,000

17. Axial compression on gross section........ $16{,}000-70\frac{l}{r}$

where "l" is the length of member in inches and "r" is the least radius of gyration in inches.

18. Bending, on extreme fibers of rolled shapes, built sections and girders; net section................16,000
On extreme fibers of pins........................24,000

19. Shearing, shop driven rivets in reamed or drilled holes ....................................11,000
Shop driven rivets in punched holes............10,000
Field driven rivets and turned bolts............ 8,000
Plate girder webs; gross section.......... $12{,}000-40\frac{d}{t}$

where "d" is the minimum unsupported distance in inches, between the flange angles or stiffeners, whichever is the smaller, and "t" the thickness of web in inches.
Pins ....................................12,500

20. Bearing, shop driven rivets in reamed or drilled holes ....................................22,000
Shop driven rivets in punched holes............20,000
Field driven rivets and turned bolts............16,000
Pins ....................................25,000
Expansion rollers; per linear inch............600 × D

where "D" is the diameter of the roller in inches.
Granite masonry .................................. 600
Sandstone and limestone.......................... 300
Portland cement concrete......................... 400

21. Members and their connections, subject to alternate tension and compression, shall be proportioned to resist either strain increased by an amount equal to 8-10 of the smaller strain.

22. Wherever the live and dead load strains are of opposite character, only 70 per cent of the dead load strain shall be considered as effective in counteracting the live load strain.

23. Members subject to the action of both axial and bending strains shall be proportioned so that the greatest fiber strain will not exceed the allowed limits for the axial tension or compression in that member.

24. For strains produced by lateral, longitudinal and wind forces, combined with certical forces, the unit strains may be increased not to exceed 25 per cent over those given above, but the sections shall not be less than required by the strains from the vertical forces without such increase.

25. In proportioning tension, the rivet holes shall be taken one-eighth inch larger than the diameter of the rivet before driving.

26. In proportioning rivets, the diameter of the rivets before driving shall be used.

27. Pin-connected riveted tension members shall have a net section through the pin-hole at least 25 per cent in excess of the net section of the body of the member, and the net section back of the pin-hole, parallel with the axis of the member, shall be not less than the net section of the body of the member.

28. Plate girders shall be proportioned either by the moment of inertia of their net section, or by assuming that the strains pass through the centers of gravity of flange sections, in which case one-eighth of the net section of the web, if properly spliced, may be used as flange section.

29. The gross section of the compression flange shall not be less than the gross section of the tension flange, and the width of the flange shall not be less than one-twelfth of the distance between its side supports.

30. The flanges of plate girders shall be connected to the web with a sufficient number of rivets to transfer the total shear at any point in a distance equal to the depth of the girder at that point, and in addition any load applied directly on the flange. The wheel loads, where the ties rest on the flanges, shall be assumed to be distributed over three ties.

31. Stiffeners shall be riveted to the web at all points of concentrated loads and also at points by the shear formula in paragraph 19. The stiffeners at bearings and other points, where they carry load directly, shall be connected to the web with a sufficient number of rivets to transmit the strain from the concentrated load, and shall be proportioned for this strain by the axial compression formula in paragraph 17. The effective length shall be assumed to be one-half the length of the stiffener. They shall, however, not be of smaller dimensions than specified in paragraph 82.

32. Rolled sections, used as beams, shall be proportioned by their moment of inertia. The width of flanges shall not be less than one-sixteenth of the distance between side supports.

33. Pony trusses and plate girders shall preferably have a depth not less than one-tenth of the span, and rolled beams and channels used as girders shall preferably have a depth of not less than one-twelfth of the span. When these ratios are decreased, proper increase shall be made to the flange sections.

IV. Details of Design.

43. Rivets carrying calculated strain and whose grip exceeds four diameters shall be increased in number at least 1 per cent for each additional 1-16 in. of grip.

45. In compression members the metal shall be concentrated principally in vertical webs and flange angles. The thickness of these webs shall not be less than 1-30 of the distance between the lines of rivets connecting them to the flanges; and any cover plate shall be as thin as possible, but not less than 1-40 of the distance between rivet lines.

47. Tie plates shall be provided at intermediate points where the lattice is interrupted.

In main members, carrying calculated strains, the end tie-plates shall have a length not less than the distance between the lines of rivets conecting them to the flanges, and intermediate ones not less than half this distance. Their thickness shall not be less than 1-50 of the same distance.

48. The minimum width of lattice bars shall be 2½ ins. for ⅞-in. rivets, 2¼ ins. for ¾-in. rivets, and 2 ins. if ⅝-in. rivets are used. The thickness shall not be less than 1-40 of the distance between end rivets, for single lattice, and 1-60 for double lattice. Shapes of equivalent strength may be used.

53. Pin holes shall be reinforced by plates where necessary, and at least one plate shall be as wide as the flanges will allow and be on the same side as the angles. They shall contain sufficient rivets to distribute their portion of the pin pressure to the full cross-section of the member.

58. Where splice plates are not in direct contact with the parts which they connect, rivets shall be used on each side of the joint in excess of the number theoretically required to the extent of 1-3 of the number for each intervening plate.

63. Expansion rollers shall be not less than 4 ins. in diameter. They shall be coupled together with substantial side bars, which shall be so arranged that the rollers can be readily cleaned.

66. Wall plates shall be securely anchored to the masonry aaginst displacement.

71. Stingers shall preferably be riveted to the webs of all intermediate floor beams by means of connection angles not less than 7-16 in. thick. Shelf angles or other supports provided to support the stringer during erection shall not be considered as carrying any of the reaction.

78. The minimum sized angle to be used in lateral bracing shall be 3½ by 3 by ⅜ ins. Not less than 4 rivets through the ends of the angles shall be used at the connections.

82. Web stiffeners shall be in pairs. Those over the end bearings shall be on fillers, the outstanding legs shall be as wide as the flange angles will allow, and they shall be brought to a close bearing against the upper and lower flange angles. Intermediate stiffeners may be on fillers or offset over the flange angles. Their outstanding legs shall be not less than 1-30 of the depth of the girder plus 2 inches. The thickness of all stiffeners shall be not less ⅜ in. and the rivet pitch in them shall be not over 5 ins.

101. For material less than 5-16 in. and more than ¾ in. in thickness the following modifications will be allowed in the requirement for elongation:

(a) For each 1-16 in. in thickness below 5-16 in., a deduction of 2½ will be allowed from the specified percentage.

(b) For each ⅛ in. in thickness above ¾ in., a deduction of 1 will be allowed from the specified percentage.

(c) For pins and rollers over 3 ins. in diameter the elongation in 8 ins. may be 5 per cent less than that specified in paragraph 92.

Special Metals.

114. Except where chilled iron is specified, castings shall be made of tough gray iron, with sulphur not over 0.10 per cent. They shall be true to pattern, out of wind and free from flaws and excessive shrinkage. If tests are demanded, they shall be made on the "Arbitration Bar" of the American Society for Testing Materials, which is a round bar, 1¼ in.

115. Wrought iron shall be double rolled, tough, fibrous and uniform in character. It shall be thoroughly welded in rolling and be free from surface defects. When tested in specimens of the form of Fig. 1, or in full-sized pieces of the same length, it shall show an ultimate strength of at least 50,000 lbs. per sq. in., an elongation of at least 18 per cent in 8 ins., with fracture wholly fibrous. Specimens shall bend cold, with the fiber, through 135 degrees, without sign of fracture, around a pin the diameter of which is not over twice the thickness of the piece tested. When nicked and bent, the fracture shall show at least 90 per cent fibrous.

123. When general reaming is not required, the diameter of the punch for material not over ⅝ in. thick shall be not more than 1-16 in. greater than that of the rivet. The diameter of the die shall not exceed that of the punch by more than ¼ the thickness of the metal punched Material over ⅝ in. thick, except minor details, and all material where general reaming is required, shall be sub-punched and reamed as per paragraph 152, or drilled from the solid. Holes in flanges of rolled beams and channels used in floors of railroad bridges shall be drilled from the solid. Those in webs of same shall be so drilled or sub-punched and reamed.

142. At least one pilot and driving nut shall be furnished for each size of pin for each structure, and field rivets to the amount of 10 per cent in excess of the number of each size actually required.

143. Screw threads shall make tight fits in the nuts and shall be U. S. standard, except above the diameter of 1⅜ in., when they shall be made with six threads per inch.

150. Payment for pound price contracts shall be by scale weight. No allowance over 2 per cent of the total weight of the structure as computed from the plans will be allowed for excess weight.

Full-Sized Tests.

164. Full-sized parts of structures shall be tested by the manufacturer if required by the purchaser. Such tests on eye-bars and similar members to prove the workmanship, shall be made at the manufacturer's expense, and shall be paid for by the purchaser, at contract price, if the tests are satisfactory. If the tests are not satisfactory, the members represened by them will be rejected. The expense of testing members, to prove their design, shall be paid for by the purchaser. The ultimate strength of eye-bars shall be 55,000 lbs. and the elastic limit 50 per cent of the ultimate strength.

The principal feature of the discussion report referred particularly to bridge loading. The association also went on record as approving the use of the word "Strain" to indicate the force acting upon or through a structure or member of the same.

SIGNALS AND INTERLOCKING.

The discussion of this report was very brief, as for lack of time the specifications and definitions which the committee had prepared at considerable length were carried over for consideration next year. Some objection was raised to the ninth conclusion, providing that all mechanically operated high speed signals shall be pipe connected as wire connections for distant signals are not reliable. Then there was some discussion relative to the eliminating the seventh conclusion altogether.

Signaling and Interlocking.

From the report of the committee present at the recent maintenance of way convention.

STANDARD ARRANGEMENT OF SIGNALS AT INTERLOCKING PLANTS.

It is desirable that signals be arranged to give full information. So long as the track layouts were confined to signal and double track junctions and crossings it was a comparatively simple matter to arrange signals so that the engineer would know what route was clear. The method of giving this information was not uniform; some roads gave the top arm for the route diverging to the right, the second arm for the route next to the left, the third arm for the route sill further to the left, etc.; other roads gave the top arm for the straight route, the second arm for the route diverging to the right, and the third arm for a route diverging to the left; if there was one diverging route only, the second arm governed it. It is obvious that with a strict adherence to either of the above arrangements the top arm would in some cases govern a low speed or switching route and the lowest arm the highest speed route. This would require the engineer to have an intimate knowledge of each situation to run with safety.

As three, four and six tracks combinations were developed, the effort to give a separate indication for each route resulted in a multiplicity of signals confusing to the engineer, as many as six arms being required in some cases. Practice has demonstrated that the spacing should not be less than 6 ft. to properly distinguish signals at a distance; this would require a mast of great height; this would be dangerous unless of very expensive construction, and under many weather conditions the top arm would be out of sight of the engineer, especially if such mast were located on a signal bridge. Furthermore, it is a proved fact that while enginemen, when running at a high speed, may know at once the indications of a three-arm mast, they are confused when confronted with more than this number of arms. Even were it practicable to give a separate signal for each route, they should be arranged to signify permissible speed at which each route may be run.

The practice on some roads is to distinguish between freight and passenger tracks by placing the signals higher for the passenger track than for the freight; but as tracks are now used interchangeably for passenger and freight service this method is objectionable.

From the above we conclude that an arrangement of interlocked signals that shall give the number of routes and the direction of divergence from a main or nominally straight route is in many cases impracticable and insufficient when practicable, unless the signification of the speed at which movements may be made over each route is added.

This speed signification is made as clear as possible and at the same time logical; easily understood and easily explained to enginemen, by locating the signals governing the high speeds high on the masts, and the signals governing low

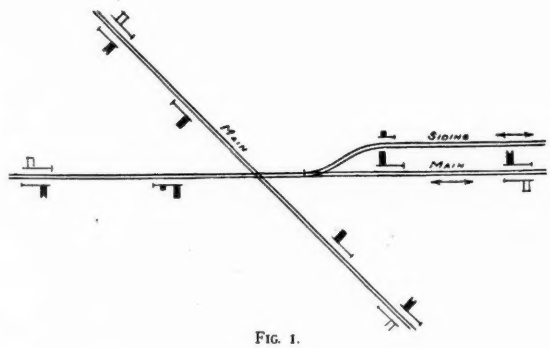


FIG. 1.

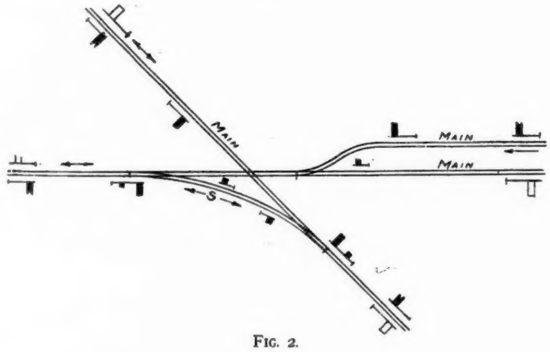


FIG. 2.

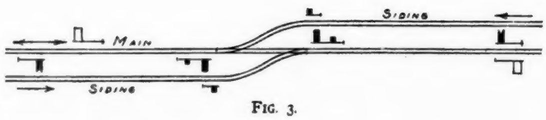


FIG. 3.

speeds low on (or near) the masts. This places the high-speed signals where (under nearly all conditions) they are most conspicuous, and keeps the low-speed signals as much as possible out of the way; a very desirable arrangement, especially where both high and low indications must be given from the same point.

While the addition of a third high-speed arm under certain conditions may be desirable, your committee is unanimous in its opinion that as a rule only two high-speed arms should appear on one mast. Fig. 4 illustrates a situation where the third arm may be useful, under the condition that all three

lines are of equal importance and all operating high-speed trains; the top arms would then relate to the straight track and would be (nominally at least) the highest speed route; the second arm would relate to the route diverging to the right, and the third or bottom arm would relate to the route diverging to the left; each arm would have its separate distant signal. Such an arrangement gives the enginemen information as to which of the two diverging routes is set, and this might prevent trouble if the operator made the mistake of setting the wrong route; but the engineer is supposed to take the route given him, because at such points trains are sent upon a particular route by the tower operator under orders from the dispatcher or under fixed rules. A mistake of this kind is not likely to occur, because the engineer must stop and investigate if he should be given other than his regular route without having previously received orders. A mistake that might result in a collision cannot be guarded against by the addition of signals, unless the responsibility for accepting a route is placed on the engineer; this is obviously im-

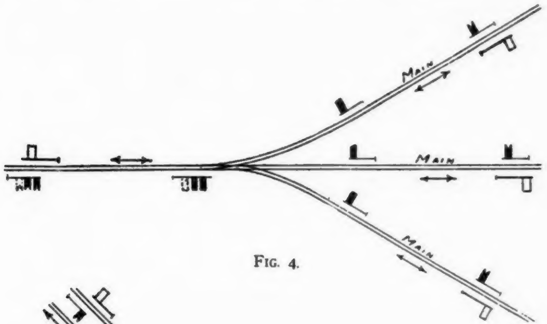



Fig. 4.

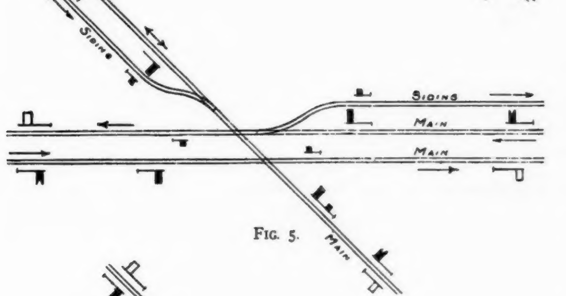



Fig. 5.

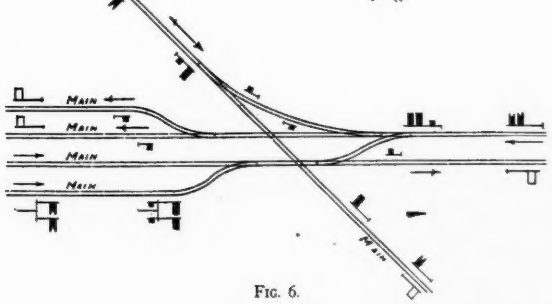



Fig. 6.

practicable. So is any effort to give signal indications for more than the general subdivision of high and low speed diverging routes. Your committee discussed the question of providing an indication for intermediate speeds, such as tonnage trains are required to make in a movement from main line to passing sidings, in order to avoid stalling, and to get out of the way of passenger trains promptly; this condition is provided for in this way: If the siding is provided with a long flat turnout, it should be signaled as a high speed diverging route, otherwise it must be governed by a low signal. It has become recognized as necessary to have long flat turnouts for important branch lines and long flat cross-overs for the passage of trains from one main track to another main track in order to run around slower trains. We are of the opinion that one arm is sufficient to govern all diverging routes of this character; but they should be made with some restriction in speed and the lower arm implies this; the top arm always refers to the highest speed route.

The signals for low speed routes should be low and of dwarf construction, because it is not intended or desirable that they should be conspicuous at any great distance, and one arm is sufficient for all low speed routes signaled from one point. Conditions calling for an exception to this rule are so rare that they serve only to prove the rule. According to the present practice low signals are used for all low speed routes, except the ones where they are most needed, namely, movements from a main line in the established direction to a siding or spur or to another main line against the established direction; many accidents have resulted from the present practice of giving a high arm for this movement. We believe it is correct to govern every low speed route with a low signal.

Since it is the function of distant signals to give preliminary information regarding home signal indications, so that the speed of trains may be governed accordingly, a separate distant signal should be provided for each high speed home signal. The present practice is to install distant signals for the highest speed only; with this arrangement trains given high speed diverging routes are required to run "prepared to stop" at the home signal; and the value of the high speed home signai is thereby decreased. Enginemen who are accustomed to get a high speed route regularly disregard this rule and interpret the caution indication relating to the highest speed to mean the "diverging high route is clear;" this is dangerous and the value of the distant indication is decreased, whereas in this day of high speeds value of the distant indication should be increased and rigidly observed.

Our sixth recommendation in regard to the color stop indication and the position stop indication for all home signals is inserted here because there has developed recently a tendency to depart from the present almost universal practice. Your committee believes that red is so firmly established as the "color stop indication" and the horizontal position of the arm as the "position stop indication" that they should not be disturbed. Blue has been used as the color stop indication for low speed dwarf signals, governing movements from one side track to other side tracks or a main track, and has been suggested for all signals governing low speed diverging routes. The argument for this is:

(a) That it will not be mistaken for a non-interlocked switch displaying a red light (the switch light does not necessarily mean stop).

(b) That it would serve to better distinguish between high speed and low speed signals, and between interlocked signals and automatic signals. It would also reduce the number of red lights that high speed trains would pass.

Some recent designs for automatic block signals show the vertical position of the arm for the stop indication. The American Railway Association has prescribed what the stop indication shall be, and we consider it proper to endorse their ruling and at the same time discourage any tendency to depart from it. There should be only one color and one position of the arm to mean stop.

While it is believed to be impracticable to present to the engine a mark of distinction conspicuous and easily memorized for all the various signals encountered on a division equipped with interlocking plants, station signals, train-order signals and automatic block signals, yet it seems very necessary to distinguish between home automatic signals past which at the stop indication trains may proceed under restrictions and other home signals requiring a stop until signal is cleared. Most roads have some sort of distinguishing mark for this purpose; for example, several use the automatic disk signal;

this gives a decided contrast with the semaphore arm interlocked signals; one road points the ends of arms on automatic signals for contrast with square end on interlocked signals; another depends on a conspicuous number plate and the difference in general outline between the automatic signals and the interlocked signals. The above examples are sufficient for day time (or night when fortunate enough to have aid of head-light); but on four-track roads with signals located on bridges, the head-light does not assist and the difference in outline no longer serves, since automatic designs are now used extensively for interlocked signals. One road has a system which requires every high interlocked

cate that both distant arms are clear through some derangement.

One road has put on the automatic signal post an illuminated letter "A" as a distinguishing mark; the disappearance of this mark converts it into an absolute stop signal. It is presumed that lights at interlocking plants being under constant supervision and within the visual range of the leverman that an extinguished light is immediately discovered; for this reason the additional lamps should be carried by the automatic signals instead of the interlocked signals. Levermen frequently extinguish lights through rough handling of the levers and fail to notice it. A great many accidents have occurred at

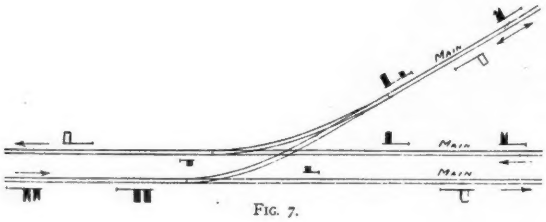


FIG. 7.

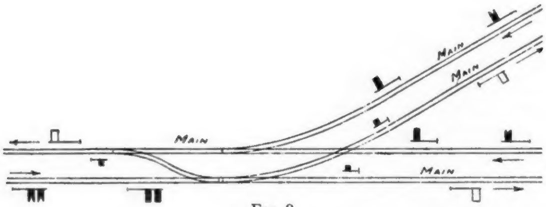


FIG. 8.

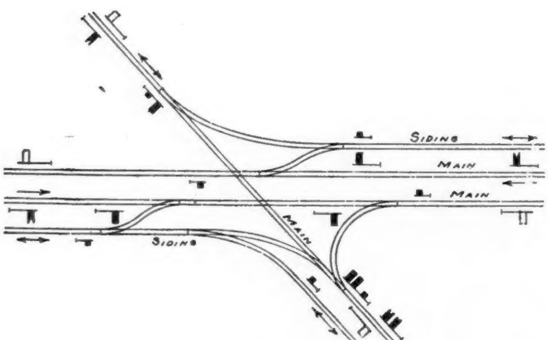


FIG. 9.

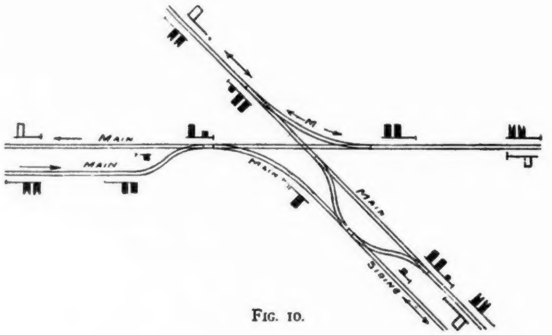


FIG. 10.

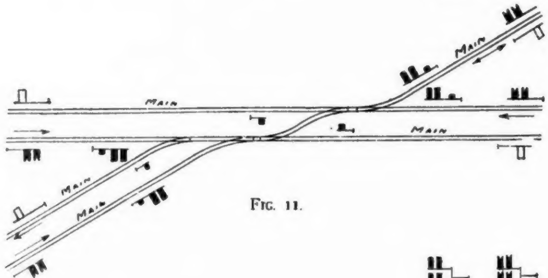


FIG. 11.

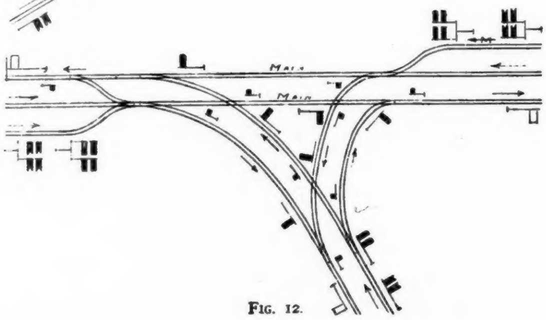


FIG. 12.

signal to display two arms and two lights (the lower arm is frequently a "dummy"—not operative—since at many points there is only one route to be governed; in such cases it always displays a stop indication); this arrangement serves as a mark of distinction and reduces the chances of accidents due to an extinguished signal light; while this has its advantages, it fails short of a final solution of the question, because a broken glass will result in a proceed indication, where white is so used, and one light out obliterates the distinction between it and one-arm automatic signals. Where green is used for "proceed," yellow for "caution," and all automatic signals carry two arms (one home and one distant), this method has only two bad combinations in the possible total of eighteen: (1) red above green, which for an interlocked signal means "proceed" at second highest speed; such a combination at an automatic signal means stop (the distant arm is stuck at clear); (2) two green lights mean "all clear" for automatic signals. But for interlocking signals two green lights indi-

interlocking points because of extinguished lights. A compromise suggestion to put an illuminated letter on all interlocked signals, locating it in such a way that it would not be mistaken or could not substitute a signal, was discussed by your committee, but failed to receive approval of the majority, so that while we recognize the importance of a distinguishing mark and of having this mark uniform for all roads, your committee has failed to agree on a specific recommendation, submitting a general one and pointing out the present variety in practice, hoping that the discussion may bring out one that can be adopted as standard.

Interlocked signals relate to the use of track within the limits of an interlocking plant. Where a block system is in force there should be signals placed at or near these limits to give permission to proceed beyond into the block. There are interlocking plants located between block signals that have no connection with them, being simply for the purpose of governing a local condition. But it is a coming practice to have

block stations at such interlocking plants, and advance signals are installed. This facilitates traffic by permitting the use of the interlocking plant as soon as the train has cleared the advance signals. Where advance signals are omitted trains are liable through misunderstanding to enter a block; for example, when they receive the "proceed" indication from a low speed signal.

The association has adopted the principle of continuous light for arm castings. This requires signal arms in the "proceed" position to be very close to the prescribed angle. From the Railway Signal Association's investigation of the subject of wire connected signals it is shown that they are not safe when operated more than 2,000 ft. from levers, as it is then found impossible to get reliability and accuracy in varying temperatures with wire connected signals. Electric signals are coming to be extensively used for distant interlocking signals. Since the distant signal is used only in connection with high-speed routes, they are required to be located 3,000 or 4,000 ft. from the interlocking tower. At this distance the operation by means of pipe line would be very difficult and expensive. All high-speed signals that are operated mechanically should have pipe connections. The low-speed signals are usually not far from the operating levers and the movements they govern being secondary and slow, nothing serious can result from a varying of the stroke.

Where clear indication is received from a distant signal it means that trains may proceed at a high rate of speed, which should therefore insure that all home signals are clear as far as the next distant signal, or when a train receives a cautionary indication at the distant signal it should mean that he may encounter a signal at the stop indication before passing out of the limits of the interlocking plant.

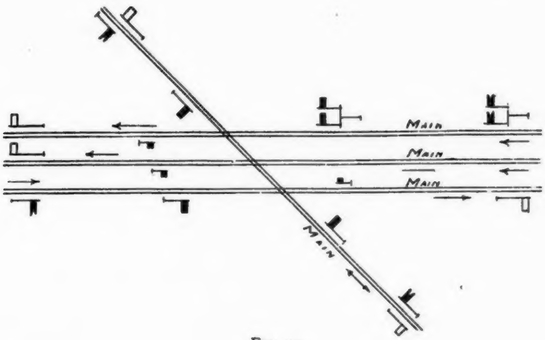



Fig. 13.

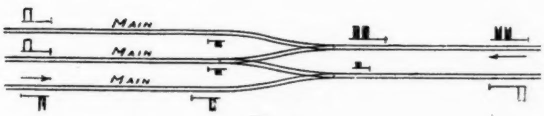



Fig. 14.

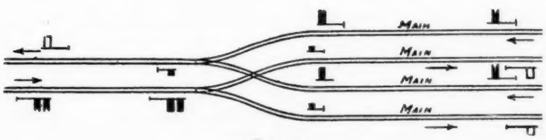



Fig. 15.

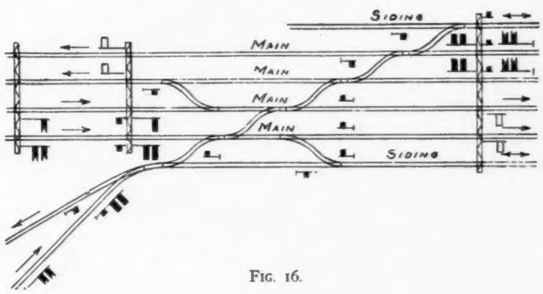



Fig. 16.

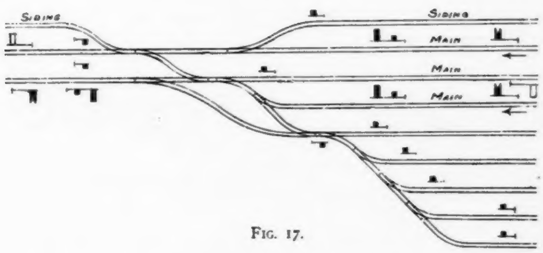



Fig. 17.

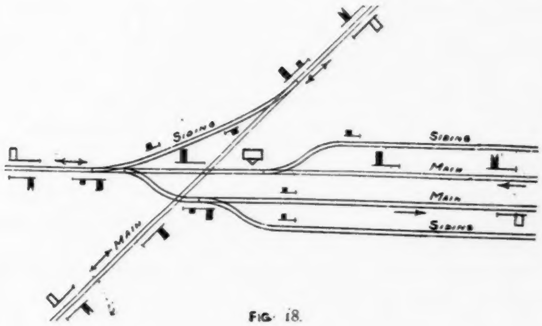



Fig. 18.

Many plants have been installed without providing signals for reverse movements; so that when such movements are made, hand signals are required. This is incomplete signaling, and has led to many derailments. To be perfectly safe, every movement made at an interlocking plant should have an interlocked signal to govern it.

Fig. B shows the outline of a design for continuous light arm casting now used extensively by many roads for automatic-block and interlocking signaling. The majority of the committee believe that such a design is demanded to reinforce the one adopted by the association for train-order signals, also used in automatic and interlocking signaling for roads using the 90-deg. sweep of the arm. It will be necessary, before detail drawings can be submitted, to have the association decide on the sweep of the arm. This should be either 60 or 70 degrees. Circular 35, shown in our last report, gives the 60-deg. angle a plurality. The committee recommends that the angle travel as represented in Figs. 2 and 3 be again submitted to the railroads for vote in case the design as shown in outline is acceptable to the association.

## Conclusions.

First. That, inasmuch as interlocking signal plants were introduced to make the passage of trains safe at speed over track layouts more or less complicated by crossovers, turnouts and crossings, the object in arranging interlocking signals is primarily to indicate routes for trains, and, secondarily, as a necessary consequence, speeds for trains.

Second. That high-speed movements be governed by high

signals, and low-speed movements be governed by low signals.

Third. That only two high-speed signals be displayed on one mast, the top arm to govern the unrestricted speed, and the lower arm to govern all other high speeds.

Fourth. That all low-speed movements be governed by one-arm low signals of dwarf construction.

Fifth. That a distant signal be provided for each high-speed route.

Sixth. That "red" be the "color" stop indication, and that the "horizontal" position of the arm be the "position" stop indication for all home signals.

Seventh. That a mark of distinction be made between automatic block signals, and all other home signals, whether interlocking, train-order or manually operated signals.

Eighth. That home block signals be provided at all interlocking plants used as block stations.

Ninth. That all mechanically operated high-speed signals be pipe connected. (Low-speed signals may be wire connected.)

Tenth. That one distant signal only shall be provided for a high-speed route, and when "clear" it shall mean that all high-speed home signals along that route through the interlocking plant, including the home block signal, are "clear."

Eleventh. That every movement within the limits of an interlocking plant shall be governed by an interlocked signal.

TELEGRAPH, AND CONTROLLED MANUAL, BLOCK SIGNALS.

The requisites of installation of a telegraph block system, as given in the Standard Code of the American Railway Association, are as follows:

Requisites of Installation.

1. Signals of prescribed form, the indications given by not more than three positions; and, in addition, at night by light of prescribed color.

2. The apparatus so constructed that the failure of any part directly controlling a signal will cause it to give the normal indication.

3. Signals, if practicable, either over or upon the right of and adjoining the track upon which trains are governed by them. For less than three tracks, signals for trains in each direction may be on the same signal mast.

4. Semaphore arms that govern, displayed to the right of the signal mast as seen from an approaching train.

5. The normal indication of home block signals—Stop.

Adjuncts.

The following may be used:

(A) Distant block signals interlocked with home block signals; normal indication—"Caution."

(B) Advance block signals interlocked with distant block signals if used, normal indication—"Stop."

(C) Advance block signals interlocked with home block signals; normal indication—"Stop."

(D) Repeaters or audible signals to indicate the position of signals to the signalman operating them.

(E) The automatic release of signals to give the normal indication.

(F) The interlocking of switches with block signals.

(G) Bell circuits for signaling between a block station and outlying switches.

(H) The interlocking of telegraph keys with block signals.

Where the semaphore is used, the governing arm is displayed to the right of the signal mast as seen from an approaching train, and the indications are given by positions:

Horizontal as the equivalent of "Stop."

Vertical or Diagonal as the equivalent of "Proceed."

Diagonal as the equivalent of "Proceed with caution."

The requisites of installation of the controlled manual block system, as given in the Standard Code of the American Railway Association, are as follows:

Requisites of Installation.

1. Signals of prescribed form, the indications given by two (2) positions, and, in addition, at night, by lights of prescribed color.

2. The apparatus so constructed that a failure of any part directly controlling a signal will cause it to give the normal indication.

3. Signals, if practicable, either over or upon the right of and adjoining the track upon which trains are governed by them. For less than three tracks, signals for trains in the same direction may be on the same signal mast.

4. Semaphore arms that govern, displayed to the right of the signal mast, as seen from an approaching train.

5. The normal indication of home block signals—"Stop."

6. The apparatus so constructed that the failure of the block signal instruments or electric circuits will prevent the display of the "clear" signal.

7. The relative position of the home signal, and track instrument, or releasing circuit, such as to make it necessary that the rear of a train shall have passed —— feet beyond the home block signal before the signal at the preceding block station can be released.

Adjuncts.

The following may be used:

(A) Distant block signals interlocked with home block signals; normal indication—"Caution."

(B) Advance block signals interlocked with home block signals and with distant block signals, if used; normal indication—"Stop."

(C) Track circuits.

(D) Repeaters or audible signals to indicate the position of signals to the signalman operating them.

(E) The automatic release of signals to give the normal indication.

(F) The interlocking of switches with block signals.

(G) Bell circuits for signaling between the block station and outlying switches.

(H) Unlocking circuits between a block station and outlying switches.

Where the semaphore is used, the governing arm is displayed to the right of the signal mast as seen from an approaching train, and the indications are given by positions.

Horizontal as the equivalent of "Stop."

Vertical or diagonal as the equivalent of "Proceed."

The information secured from the replies to Circular No. 40 is presented in the accompanying Table "A" for telegraph block system, and Table "B" for controlled manual block system, and by the diagrams of signals used by the several railroads.

For convenience in presenting and analyzing the statistics given in its annual reports on railways, the Interstate Commerce Commission has divided the United States into ten groups, illustrated by a map. It seemed to your committee a wise thing to adopt the same grouping, and, through the kindness of the commission, they have received permission to use the same map for illustrating the territorial groups.

By reference to Table "A," it will be seen that there were in the United States June 30, 1902, 200,155 miles of railway line based on single-track mileage only, and that the answers received represented 103,435 miles, or 51½ per cent. Of the miles reported only 15,937 miles, or 15¼ per cent, were being operated under the telegraph block system, and 942¼ miles, or nine-tenths per cent, under the controlled manual block system.

The information given about the block rules was not very complete, as the table will show, but nevertheless the operations are generally conducted under the "Standard Code of Block Signal Rules" of the American Railway Association, adopted April 25, 1900, showing how influential that association has become in a few years. One railroad uses this

code almost verbatim; others adhere very closely to it, while others again have made quite extensive modifications.

It has been impossible to prevent the overlapping of the lines in different groups because the reports were not made in sufficient detail, but the committee hopes that these divisions may be more accurately made in future statistics. Footnotes in the table explain where these overlays occur.

From Group No. 1, embracing the New England states, and from Group No. 9, embracing Texas, Louisiana and half of New Mexico, no information on the telegraph block system was received, although 14.9 per cent of the mileage of line in the first and 19 per cent in the second group reported.

The railways of the Atlantic Coast states (except New England), and the middle and northwestern states, represented by Groups 2, 3, 4, 6 and 7, are the most extensively operated under the block system in question. These groups can apparently be subdivided a second time according to the

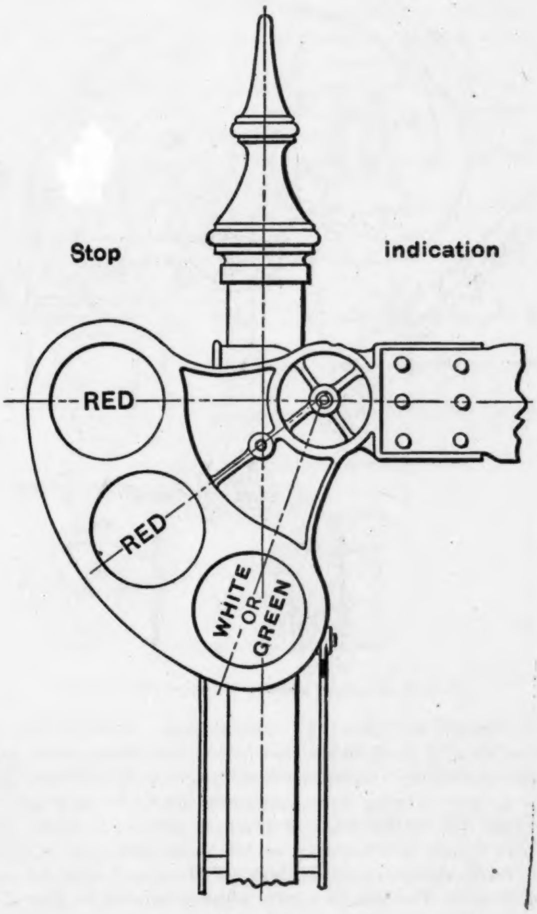



FIG. B.

method of operating a "Permissive Block System." The Atlantic Coast states and the Middle states, Groups 2, 3 and 4, give the permissive indication by the fixed signal arm, while the Northwestern states, Groups 6 and 7, give permission by "Caution" or "Permissive" cards. To this latter subdivision is also added Group 10, the Pacific Coast states.

While the replies from Group 5—Kentucky, Tennessee, Mississippi, Alabama, Georgia and Florida, and from Group 8—Missouri, Arkansas, Kansas, Colorado, Oklahoma and Indian Territories, represented a large mileage, 32 per cent in the first case and 63 per cent in the second, yet the use of the telegraph block system is quite limited.

There are but four roads in the table which employ the telegraph block system or more than 50 per cent of their line. Of these the New York Central has the largest mileage, 1,881, or 65 per cent, while the Norfolk & Western has the largest percentage, 76, or 1,280 miles. The third is the Wabash with 50 per cent, or 1,044 miles, and the fourth, the Lehigh Valley, with 50 per cent, or 668 miles. Other roads, however, have a large mileage operated under this system; the Pennsylvania, 1,287 miles, or 25 per cent; the Lake Shore, 1,008 miles, or 37 per cent; the Chicago & Northwestern, 1,505 miles, or 25 per cent; the Chicago, Milwaukee & St. Paul, 2,463 miles, or 37 per cent; the Santa Fe, 1,045 miles, or 13 per cent.

Of course it must be borne in mind that some roads which are weak in the telegraph block system are strong in the automatic block system, which is not under consideration at the present time.

On account of its bearing on the requirements which a telegraph block signal has to meet it will be interesting to note some differences from the Standard Code of Block Signal Rules.

On the Long Island Railroad the time which a train must wait at a block station before proceeding past the signal at danger in case the signalman is absent or incapacitated so

Fig. 28
SINGLE TRACK

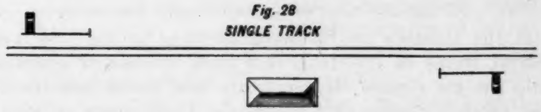


Fig. 29
DOUBLE TRACK

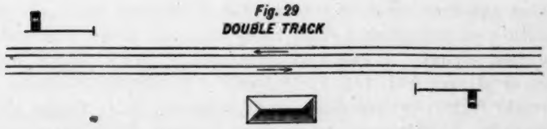


Fig. 30
FOUR TRACKS

Fig. 31
FOUR TRACKS

that instructions cannot be obtained is 3 minutes; on the Pittsburg, Cincinnati, Chicago & St. Louis Railway it is 5 minutes, and on the Chicago & Northwestern and Southern Pacific it is 10 minutes. A bell code is used in place of the prescribed telegraph signals on the Long Island Railroad and seems to be about the best submitted. It is as follows and almost exactly the same as the bell signals prescribed under the controlled manual block system rules of the American Railway Association.

Ring

2. All right. Yes.
3. Is Block clear? Answer by 2 or 5.
4. Train has entered block. Answer by 2.
5. Block is not yet clear. Answer by 2.
6. Is there a train coming to me? Answer by 2 or 2-1.

1-2. Clear. Train has passed. Answer by 2.

2-1. No.

5-5-5. Obstructions. Danger signal. Stop all trains approaching this station. Answer by repeating.
3-3-3. . . . . . 3-3-3. Train proceeding toward you has broken apart. Answer by repeating.
4-4-4. Cars running away on wrong track and proceeding toward you. Answer by repeating.
4-6-4. Cars running away on right of track and proceeding toward you. Answer by repeating.
2-3-2. Train passed without markers. This signal to be given station in advance. Answering by repeating.
5-2-5. Train passed without markers. This signal to be given station in rear. Answer by repeating.
1-4-1-4. Stop and examine train. Answer by repeating.
3-3. Train is on siding. Clear of main track. Allow train to enter block under caution card C. T. 89 B. Answer by repeating.
5-5. Train crossing over to opposite track. Answer by repeating.
2-2-2. Previous signal given in error. Answer by 2.
6-6-6. Testing. Answering by repeating.
1. (Long Stroke.) Answer telegraph call.
Note: ( . . . ) signifies pause between beats.
Note: All signals must be repeated until answered.

On the Mohawk and Western divisions of the New York Central, trains on three and four-track systems, if preceding train has not cleared the block, are held for 15 minutes and then given a caution card, unless the block clears before the 15 minutes have elapsed. On the Pennsylvaia division, freight trains arriving at block station, the block in advance not being reported clear, must be held 5 minutes after the departure of preceding freight train and then given a green or caution signal. A red and green blade on the same mast are used (see Fig. 19), the latter for permissive blocking of freight trains, but not for passenger trains. A passenger train following a passenger train must be held 10 minutes after the preceding train, and when following a freight train 5 minutes after its departure, unless the block section is reported clear before that time; but if the section is not reported clear it may only proceed with a caution card. The standard code is not used by the Pennsylvania division.

The rules of the Chicago & Northwestern are based on the "Standard Code," but are quite differently arranged. They emphasize by a rule that "block signals are to be used to control movement of trains upon main track and must not be accepted by trains on side tracks." Trains are only permitted to pass a block signal at danger under "proper authority," which consists of

(a) A caution card and release.
(b) A release stamped "Block is Clear."
(c) Train Order stamped "Block is Clear," or
(d) Train Orders and Caution Card.

In blocking trains a telegraph code of signals different from the "Standard" is used.

The Block Rules of the Chicago, Milwaukee & St. Paul are not entirely the same as the "Standard Code." Trains can only pass a block signal at danger with "Clearance" or "Permissive" cards, and when they have a "Permissive" card they must also have a "Clearance" card. At certain block stations a permissive arm painted green placed below the block arm is used for moving trains permissively. When a block station is closed the block light must be left burning, which is the contrary of the standard code rule and the general practice of other roads, the theory being that the absence of a signal from its usual place is a danger signal.

The Wabash rules are not arranged like the "Standard Code," and different telegraph signals are used. Trains are moved "permissively" by the use of clearance and caution cards. The type of signal is shown in Fig. 27.

The Block rules of the Atchison, Topeka & Santa Fe are not in the form of the Standard Code. A clear block signal indicates that the block is clear to a point 1,000 feet before reaching the next home block signal. Permissive blocking for freights is allowed, but not when a passenger train is in the block.

The Southern Pacific (Pacific System) operates under the "Standard Code," but the telephone is used instead of the telegraph. This naturally leads to bell signals between stations, and the code employed is closely similar to that already quoted for the Long Island Railroad. The operations are conducted under "absolute block," except that caution cards are used for failure of the block signal apparatus and permissive cards to allow trains moving in the same or opposite directions to meet at a non-block signal station with "(31)" orders to do so.

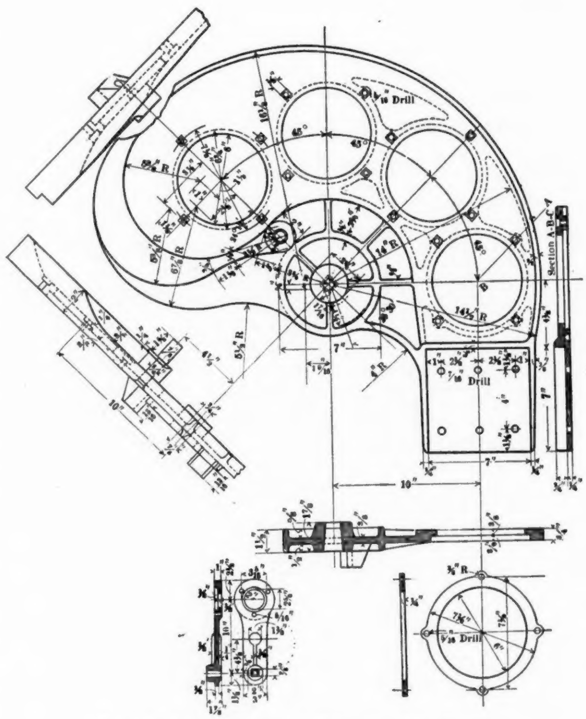


Plate B.—Detail of Standard Semaphore Arm Casting.

Reference to Table "A" will disclose the fact that the same form of fixed signal that is used for Train Orders is almost universally employed for a Telegraph Block Signal. At the present writing your committee knows of only one exception, the Philadelphia & Reading Railway. Their Train Order Signal is illustrated in Vol. 4, p. 305, Fig. 12, while the block signal is pictured in Figs. 20, 21 and 22 of the present report. The signals which were illustrated in Vol. 4, pp. 300-305, have not been reproduced, and new designs only have been shown in the present report. Figs. 1 to 7, Table A, explain in one column where the illustration is to be found in Vol. 4. There is, as usual, wide variance in the design, for which there seems to be no good reason. It seems quite plausible to your committee that the members of the association can ultimately agree upon a standard plan, an action to be desired by both the railways and the signal companies. Present practice would indicate that at least the Train Order and Telegraph Block Signals can, without difficulty, be of the same design.

There are reported 11,248 miles of single track, 4,806 miles of double track and 825 miles of more than two-track line as operated under the Telegraph Block System and Controlled Manual Block System, and this requires the use of 3,426 sig-

nals for single track, 3,534 signals for double track and 2,142 signals for more than two-track line, a total of 9,102 signals.

The Baltimore & Ohio uses a double-arm semaphore on a single mast (Vol. 4, p. 302, Fig. 6), located at the passenger station or on block stations (Vol. 4, p. 306, Figs. 14 and 17). The arms have a sweep of 90 deg. and are not slotted, but at interlocking plants where signals are convenient for block purposes the arm is operated by two levers, the first reversed giving the "caution" indication, while the second reversed completes the movement for "clear." The plan insures the correct indication of the arm, but does not actually prevent the operator from giving a "clear" indication instead of a "caution." It economizes in signals and pipe run, only one line of pipe being used.

Since the Long Island Train-Order Signal was illustrated in Vol. 4, p. 300, that company has added a spectacle to carry a green glass on account of having adopted green for "proceed" and yellow for "caution." The signals are placed on the block system or alongside the track (Vol. 4, p. 307, Figs. 17 and 20). Whenever the view is obscured a distant signal is added. The block signals are pipe connected.

The New York Central has a two-arm signal on a single mast with distant signals 6 feet below on the same mast, which is placed on the block station (Vol. 4, p. 307, Fig. 17). The arms are two-position, with a sweep of 60 deg., and are operated by a table machine, Fig. 19.

The Philadelphia & Reading uses a two-arm three-position signal on one mast, Figs. 20, 21 and 22, the arms of which are pipe-connected and have a sweep of 45 degs. for "caution" and 75 degs. for "proceed." It is placed either on the block station or alongside the track (Vol. 4, p. 306, Fig. 14, and p. 307 Fig. 20). The reason for using a different form for train orders was not given.

The Pittsburg, Cincinnati, Chicago & St. Louis (Pennsylvania Lines) has been using the form shown in Vol. 4, p. 302, Fig. 7, placed on the block station (Vol. 4, p. 306, Fig. 14), but is now making renewals with, and using in new work, the universal casting recommended at the fourth annual convention and illustrated in Vol. 4, p. 311, and Plate 13, and places the mast alongside the tracks (Vol. 4, pp. 306-308, Figs. 17, 20 and 21), or on bridges over the tracks. The face of the blade is painted yellow and the back black, similar to the Baltimore & Ohio. This style of painting is now uniform on the Pennsylvania System, east and west of Pittsburg. At tunnels the block signal arm is slotted, goes to "danger" as the train passes, and is held there by means of the track circuit until it has passed out of the block, the block being absolute. Three-position signals are pipe connected.

The Lake Shore & Michigan Southern Railway is unique in the style of block signal used. It is illustrated in Fig. 24 and is called the Gravit signal. While it is a semaphore signal, it is used to give some indications at variance with the usual indications of the semaphore arm. It is not used on any other railway. A lamp travels up and down inside the mast with the movement of the arms and gives the correct night indication through properly colored glasses fixed in the mast.

The Chicago & Northwestern standard is the Sanborn signal (Vol. 4, p. 304, Fig. 11) placed in front of the block station (Vol. 4, p. 307, Fig. 18). The mast is made of two rails, with the bases riveted together and spread at the top to receive the lamp. It is two-arm and two-position.

The Chicago Great Western block signals are two-arm and two-position, Fig. 25, and placed at the passenger stations (Vol. 4, pp. 306 and 307, Figs. 14, 15, 17 and 18).

All of the signal blades above described have the square end, but that of the Chicago, Milwaukee & St. Paul has a spearhead end (Fig. 23). The signals are two-arm, two-position, wire-connected, and placed either opposite the station or at one end.

The Atchison, Topeka & Santa Fe Telegraph Block Signal also has a spearhead blade and is double-arm but three-position. The "caution" indication, however, is given in an entirely different way from any of the others described, viz.: 45 deg. upward. The "proceed" position is 45 deg. downward (Fig. 26). The mast is placed in front of the block station.

The Southern Pacific used a two-arm two-position signal (Vol. 4, p. 301, Fig. 4), the sweep of the arm being 60 deg. or more for "clear." The mast is placed in front of the block station (Vol. 4, pp. 306-307, Figs. 14 and 17).

It will be seen from the foregoing that the location of the Telegraph Block Signal is generally on the block station and that the arms for both directions of traffic are on the same mast. The arrangement serves the purpose very well for single or double track lines, but the indications become confusing for lines of more than two tracks. The increase in the number of tracks takes place in a regular way and according to a plan of evolution. The same should be the rule with the block signal. The rules for signaling should be based on well defined principles, so that the plans for a special case will work themselves out naturally by reason of the basic principles. It should not be necessary to make a new plan to fit every condition that arises. According to our present practice we started in with a two-arm signal on a common mast for a single track and continued it in service for double track; but when we were confronted with a larger number of tracks our signal was incapable of expansion and we were obliged to adopt the one-arm signal on a single mast for each track. It seems to your committee that we should begin with the mast and arm for each track, and the arrangement is then capable of indefinite growth. The natural position for such a signal is alongside the track used by the trains it is intended to govern and on the right hand side, which is one of the requisites of installation of the American Railway Association.

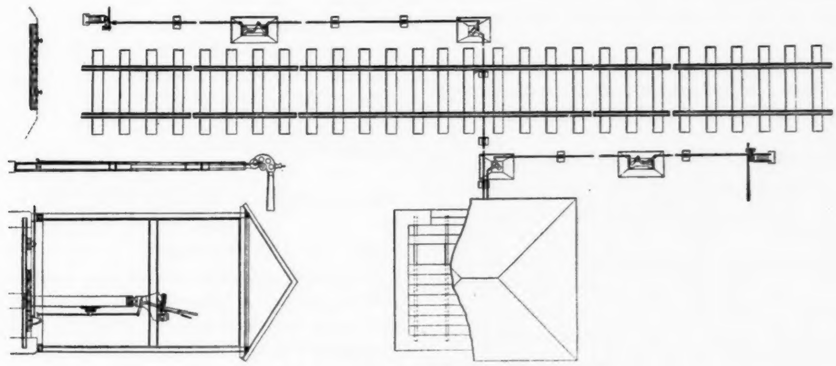


PLATE C—LEADOUT AND PIPE RUNS FOR TELEGRAPH BLOCK SIGNAL

The location of the signal on the block station is awkward, because when the block station is in the passenger station trains are often obliged to run by it at danger when coming to the station or doing work in its vicinity. The one-arm one-mast signal can be placed a few hundred feet in advance of the station and the train makes its stop before reaching it. When allowed to proceed the arm can be cleared for it without it being necessary to issue a clearance card. This saves work and time. It is the opinion, therefore, of your committee that the signals should be located as shown in the diagram in Figs. 28 to 31. This location for train-order signals was approved by the association at the fourth annual convention in 1903, and is entirely consistent with the former action.

Permissive block signaling is recognized by the American Railway Association as good practice, and rules governing its use have been provided in the Standard Code. As already stated, some of the roads give the permissive indication by the caution position of the block arms; others by the issuance of caution or permissive cards, and a few by the indication of a separate caution signal on the same mast with the block arm. It seems advisable, therefore, to your committee to provide a signal which can be used to give the three indications as well as two, and either method of operation at the pleasure of the company can be followed by use of the same fixed signal. In order that the several indications be clear and distinct from each other, such a signal should have a sweep of arm of 90 deg. That is, the arm would be vertical for the "proceed" indication, and at an angle of 45 deg. for the "caution" indication. A signal which meets these requirements is shown in Plate B. The arm casting is universal and can be used for any combination of night signals in common use. It is the same design that was adopted by the association for train-order signal at the fourth annual convention in 1903, except that some defects in size of parts have been remedied.

It is a good plan to put an electric slot on the signal-arm connection to insure the return of the arm to danger as the train passes. It is an additional safeguard and especially valuable in the absolute block system. While it does not prevent the operator from giving a wrong indication in the case of permissive blocking, it requires him to reset the signal for each train.

Only a very few of the railroad companies appear to have standard specifications for the leadouts, pipe runs and signal connections, and your committee therefore presents a set of proposed standard specifications for your consideration, with a general diagram, Plate C, which illustrates on a small scale the relation of the various parts from the block station to the signal.

There are but eight roads in the table which use a Controlled Manual Block System. Of these the New York Central & Hudson River Railroad has the largest mileage and largest per cent—451¼ miles, or 48 per cent. The second is the New York, New Haven & Hartford Railroad—225 miles, or 24 per cent.

The bell code used on these roads conforms to that adopted in the standard of the American Railway Association.

Description of Controlled Manual Block System.

In Controlled Manual Blocking the manipulation of the signal at the entrance to a block is controlled electrically by signalmen at block station in advance.

There is at each block station a track circuit of at least 60 feet in length, which is used to actuate an electric slot and automatically restore the Home Signal to stop position when the first pair of wheels touch the track circuit.

Each block station has an instrument for each track and block, the two instruments at opposite ends of the block being connected by an electric circuit. These instruments consist, primarily, of a series of electric magnets so connected with the lever by which the operator moves the signal that the operator at out-going end of the block section controls the lever by which the operator at the in-coming end admits the trains.

After the signal has been cleared to admit a train and train has passed the first block station, this arrangement of magnets cannot be unlocked until the train itself actually passes out of the section. Thus: After "A" forwards a train to "B" and puts his lever normal, he is unable to again move the lever until "B" unlocks him. This is accomplished by running an electric circuit which controls the lever through a track circuit beyond "B," and the action of a train going on "B" section and going off of "B" section completes the series of make-and-break contacts, which must be accomplished before "B" can again unlock "A."

W. R. Sykes is the inventor of the "Lock-and-Block" system, as it is called in England, where it originated, and it has been introduced in this country on the railroads enumerated in Table B. The Sykes instruments have some defects which have been overcome in the apparatus of T. H. Patenall, when electrician of the Johnson Railroad Signal Co., now with the Union Switch & Signal Co., and John P. Coleman, chief engineer of the Union Switch & Signal Co.

In the original Sykes apparatus "each lock instrument controlled the signal lever at its own station by mechanical means (rods) instead of by an electric lock." Patenall's improvements were designed to meet the following requirements: (Block and Interlocking Signals, by W. H. Elliott).

"First. That gravity must be overcome by the action of the electric current in unlocking the signal levers instead of allowing it to assist, as it now does, in withdrawing the lock rod from the locked position. This means nothing more than that a failure of the apparatus should lock the signal lever at danger and not unlock it, as now happens with the Sykes lock if the latch holding the lock rod in place should slip or be jarred loose, allowing the operator to clear the signal whether the block was occupied or not.

"Second. That the magnets for unlocking the signal levers must not be in the electric circuit except at the moment of actual use to prevent an accidental release by the crossing of wires, lighting or other causes; this requiring an intentional setting of the instrument before it can be plunged to and released by the next succeeding station.

"Third. That no interlocking relay must be used, the contacts all to be made in the instrument, where it is impossible for them to be tampered with or changed.

"Fourth. That the signal levers be perfectly free after having been once locked, so that the operator can change he indication of the signal as often as he desires and not to have the lever locked whenever the signal is returned to the danger position, as is the case with the Sykes."

The Patenall system is in use on the New York Central & Hudson River Railroad between New York and Poughkeepsie; on the New York, New Haven & Hartford Railroad between New Haven and Providence and on the Long Island Railroad.

The Coleman system is in use on the New York, New Haven & Hartford Railroad between Boston and Providence, and on the New York Central between Poughkeepsie and Buffalo.

The Sykes lock and block system and its modifications by Coleman and Patenall was designed for double-track railroads (or more than two tracks) and permissive blocking cannot be used. This requires the block stations to be very close together on railroads with heavy traffic, and, accordingly, the automatic block signal system is more used in this country.

A controlled manual system for single-track railroads has been patented by Messrs. Fay and Basford, but your committee has no knowledge of its application.

Mr. B. B. Adams in his book, "The Block System," describes

a modified form of lock-and-block instrument devised by M. B. Leonard for the Chesapeake & Ohio, but no further description of any of these instruments will be detailed here, because they have been so well described in Mr. Elliott's and Mr. Adams' books, already mentioned, and the members who are interested are referred to them for an excellent presentation of the whole subject.

The committee makes no recommendations concerning the details of the controlled manual system, because they are exemplified almost exclusively for modern practice by the Coleman and Patenall apparatus, and the development and installation of the automatic block signal system is proceeding much faster. The scope of the controlled manual system is quite limited. The same type of fixed signal should be used as recommended for the telegraph block system.

Conclusions.

First. The best location for the telegraph, and controlled manual, block signal is on a mast alongside and to the right of the track on which are run the trains that it governs, as shown in Fig. 29; but in the case of more than two tracks, when it is impracticable to spread them apart for this purpose, then the best location is on a bracket post, as in Fig. 30, or on a bridge over the tracks, as in Fig. 31.

Second. It is good practice to make use of the electric slot to send the block signal to normal position, "Stop," as the train passes.

Third. The best "Arm" for the "Telegraph," and "Controlled Manual Block Signal" to be recommended as standard by the association is the one illustrated in Plate B.

Fourth. The plan for "Leadout, Pipe-runs and Signal Connections," shown in Plate C, is recommended as good practice.

YARDS AND TERMINALS.

The discussion on this report was very brief and consisted in a few changes, which are given as follows, in the revised form:

Terminal.—The facilities provided by a railway at a terminus or an intermediate point on its line for the purpose of handling its business.

Yard.—A system of tracks arranged in series, within defined limits, provided for separating and making up trains, storing cars and other purposes. Movements not authorized by time tables or by train orders may be made over these tracks, subject to prescribed signals and regulations.

Receiving Yard.—A yard for receiving incoming trains.

Separating Yard.—A yard adjoining a receiving yard, in which cars are separated according to district, commodity or other required order.

Classification Yard.—A yard adjoining a separating yard, in which cars are classified or grouped in accordance with requirements, preliminary to forwarding in trains.

Departure or Forwarding Yard.—A yard in which cars are assembled in trains ready for leaving.

Cluster or General Yard.—An arrangement of yards in series for the separation, classification, assembling and storage of cars.

Gravity Yard.—A yard in which the separation or classification of cars is aided by gravity.

Assisting Grade.—The inclination given to one or more tracks of a yard to facilitate the movement of cars in separating or classifying.

Switching District.—That portion of a railway at a large terminal into which cars are moved and from which they are distributed to the various sidetracks and spurs to freight houses and manufacturing establishments served from this district, by yard or switching engines.

Rail and Water Terminal.—A terminal where freight is transferred from railway to vessels (or vice versa).

Piers.

Lighterage Pier.—An open or covered pier at which freight is loaded directly from cars to vessels (or vice versa).

Export Pier.—A covered pier in which freight is unloaded and stored, mainly for shipment on ocean or coasting steamers.

Station Pier.—A covered pier having no rail connections, and where freight is received and delivered by car floats.

Coal Pier.—An open pier where coal is transferred from cars to vessels or barges.

Conclusions.

The recommendations submitted are considered to embody the general principles to be followed in yard design, although local conditions as to site or operation may frequently necessitate a deviation therefrom.

Body Tracks.—These should be spaced 11 feet 6 inches to 13 feet centers; and where they are parallel to the main track or other important running track they should be spaced not less than 16 feet center to center from said track.

Ladder Tracks.—These should be spaced not less than 15 feet center to center from any parallel track; and a No. 7 frog is the minimum number recommended for yard use.

Lead Tracks.—For safety the connection of these tracks with the main line should be interlocked; and to facilitate train movements, telegraphic connections should be established in the tower.

Running Tracks.—These tracks should be provided for movements in either direction to enable yard engines to pass freely from one portion of the cluster or general yard to the other; also for road and yard engines to go to and from the engine house and other points where facilities are located.

Crossover Tracks.—Crossovers should be located at the most convenient points, and where they will least interfere with regular movements.

Caboose Tracks.—These tracks should ordinarily be located between the receiving and departure yards and so arranged that the caboose can readily be pushed thereon from a receiving track and then dropped by gravity to the train departing in the direction from which the caboose has arrived.

Scale Track.—These tracks should be located between the receiving and separating yards.

Coaling, Ash Pit, Sand and Engine Tracks.—These tracks should be located on the route leading to and from the engine house and should provide sufficient storage for the reception of engines by the hostler. They should be so arranged (1) that water, coal and sand can be taken and ashes disposed of in convenient rotation; and (2) that switching engines may clean fires, take coal, water and sand, and pass around waiting engines.

Bad-Order Tracks.—Where cars are classified, one or more of these tracks, easy of access, should be provided for setting off bad-order cars, and from which they can readily be removed to the repair tracks.

Repair Tracks.—These tracks should have a maximum capacity of about 15 cars each, spaced alternately 16 feet and 24 feet center to center, and be connected conveniently with the bad-order tracks.

Y Track.—A triangular arrangement of tracks used in place of a turntable for turning engines, cars or trains.

Transfer Slip.—A protected landing place for car floats, with adjustable apron for connecting the tracks of the pier and car float; the outer end of apron is generally suspended by adjustable chains and sometimes assisted by pontoon support.

Siding or Side-Track.—A long track away from a yard connected with the main or running track at both ends and used for the storage or irregular movements of cars or trains.

Passing Siding.—A special siding, usually connected with the main track at both ends, and used to enable trains to

pass on single track, or to relieve fast traffic on double track.

Relief Track.—An extended passing siding, long enough to allow an inferior train to continue running.

Stub Track.—A short track connected with another at one end only.

Spur Track.—A stub track, usually leading to and serving an industry, or warehouse, freight house, etc.

House Track.—A track alongside or entering a freight house and used for cars receiving or delivering freight.

Summit and Gravity Yards.

In the consideration of summit (or hump) and gravity yards, specially assigned at the last annual meeting for the ensuing year's work, with special recommendation by the board of direction as to linear feet of track to assume in rating car standing capacity of yard tracks, also spacing the grouping of tracks in car repair yards and team delivery tracks, your committee reports that there has been a full discussion of these subjects, the result of which is submitted herewith in concise form:

In response to a letter addressed by the chairman of the committee to Mr. W. J. Wilgus, Fifth Vice-President of the New York Central & Hudson River Railroad, on this subject, Mr. Wilgus writes as follows regarding the practice on his road:

"Linear feet of track per car used in rating capacity of yard tracks, 40 feet.

"Spacing and Grouping of Tracks in Car Repair Yards.—Our usual practice is 24 feet center to center of tracks where we are not cramped for room, as this gives ample room for the storing of materials and the passage of men, and, furthermore, permits the laying of an additional track in the open space when change of conditions so requires. The car repair yards were usually located ahead of the classification yards, and so placed that one of the classification tracks could be used for cripples, which could then be shoved ahead directly on to the repair tracks.

"Team Delivery Yards.—The tracks in these yards are usually grouped in pairs, 12 feet centers, with intervening driveways 36 feet between centers of tracks. This leaves ample room for teaming and at the same time permits two additional tracks to be laid in the driveway space should a revision of the yard be required."

Summit (or Hump) Yards.

Conclusions.

Definition.—A summit or (hump) yard is a yard which has a portion of its tracks elevated above the general elevation of the yard, for the purpose of giving cars which are being separated or classified an impetus by a down grade or incline which enables them to run on to the different tracks in the yard without other assistance.

Elevation and Grades.—The amount of elevation of summit and rates of grades required vary with different kinds of cars and traffic handled, and also with varying climatic conditions; i. e., cars run easier in summer than in winter, loaded cars run easier than empty cars, etc.

The tracks approaching the summit should be slightly up grade for about 75 feet, to insure cars being closed up, so they can be uncoupled rapidly.

The exact grades of each summit must be determined by experience with the class of business handled, but fair average grades for this purpose are about as follows: From the sumit down for 300 feet, 2 per cent; thence down through the several switches in the yard, 0.7 per cent; thence down through the remainder of the yard, 0.3 per cent. It may be stated that in general the grades after leaving the summit should be such as to carry the cars to their proper destination.

Location of Scales.—When scales are located on the summit they should be so placed that when the cars reach the scales they will be running slow enough to render correct weighing easy. The distance of the scales from the summit, and also the rate of grade, should be such that the car as it reaches the scales should be separated from the cars following.

Length and Number of Yard Tracks.—The lengths of tracks required for summit yards will vary, being dependent largely upon the existence of receiving, classification and departure yards. When all these conditions exist, the receiving tracks should be long enough to hold full-length main line trains; the classification tracks should be about one-half the length of the receiving tracks (care being taken to provide a sufficient number of tracks for the classification desired), and the departure tracks should all be of full train length. In case there is no departure yard, the tracks of the receiving and classification yards should both be of full train length. The number of tracks in the receiving yard should be sufficient to hold the maximum number of trains that may be received in two hours. The number of tracks in the departure yard should be sufficient to hold the maximum number of trains made up in six hours, so that delay in dispatching trains may not limit the working capacity of the yard.

Rating Car Standing Capacity of Tracks.

Conclusion.

Rating Car Standing Capacity of Tracks.—Forty (40) linear feet of track per car seems to be the universally recognized rule for distance assumed in rating car standing capacity of freight yard tracks. No other distance has been suggested, and hence your committee feels safe in recommending 40 feet as good practice.

Car Repair Yards.

Conclusion.

Heavy car repair tracks should be under cover, and provided with overhead cranes, to facilitate heavy lifting. They should preferably be short, of a capacity of ten to twenty cars each and arranged in pairs; the track of each pair should be spaced 16 feet centers, and the pairs themselves 40 feet centers.

WATER SERVICE.

A short discussion followed this report and the parts of the report that was adopted are as follows:

Problem 1.—Water-Softening Methods and Plants for Various Conditions.

Summary of Problem 1.

(1) All water used in locomotive boilers contains scale-forming matter in solution or suspension, that is the cause of much trouble and expense in operating and maintaining locomotives.

(2) In locating water stations along a railroad, an investigation should be made of all the available water supplies, and care should be taken to avoid the use of poor water, or to curtail its use as much as possible.

(3) If hard water is used, the hardness should be removed before it is put into locomotive boilers.

(4) Hard water can be softened by treating it with chemicals. The chemicals generally used are lime and soda ash.

(5) The chemical methods of softening water, commonly used today, has been known for many years.

(6) The mechanical methods of modern water-softeners are new and differ widely.

(7) Water, whose hardness is due to carbonates of lime and magnesia, can be softened by the use of lime alone, without adding any soluble salts to the softened water.

(8) Water, whose hardness is due to sulphates of lime and magnesia, can be softened by the use of soda ash, but in this case soluble sulphate of soda will be added to the softened water.

(9 A water-softening method best adapted to any condition can be determined only after a study of that condition.

Problem II.—Comparison of the Cost of Installing and Operating Water-Softening Plants, With the Benefits Derived From Their Use.

Summary of Problem II.

(1) The cost of installing a water-softening plant varies according to the capacity of the plant, its type, cost of material and labor in its locality, and other local conditions.

(2) The cost of operating a water-softening plant varies according to the efficiency of the water-softening apparatus, and cost of lime and soda ash and other chemicals in its locality.

(3) The cost of chemicals required to soften water varies according to the quantity of hardening matter in the water, and also its composition.

(4) If the hardening matter consists of carbonates of lime and magnesia, the cost of chemicals for softening the water will be very little, because common lime is the only chemical required.

(5) If the hardening matter consists of sulphates of lime and magnesia, the cost will be higher, because it will be necessary to use soda ash, or some more expensive chemical.

(6) The average cost for chemical and labor on the Santa Fe was 2.8 cents per 1,000 gallons; on the Northwestern it was 1.8 cents per 1,000 gallons; on the Southern Pacific the average cost for chemicals only was 4..4 cents per 1,000 gallons, and on the Union Pacific it was 1.3 cents per 1,000 gallons.

(7) The benefits derived from water-softening plants are:

Fewer boiler failures due to leaking.

Longer life of flues and firebox sheets.

Reduced cost of labor for repairing and washing boilers.

Increased locomotive mileage between stoppings.

Increased ton mileage per pound of coal consumed.

Decreased number of locomotives in service.

Shorter time required for locomotives to go over the road.

Better feeling among the men, due to fewer failures and shorter time on the road.

Less expense in cost of overtime and delayed time.

Problem III.—General Conditions Under Which the Installation of Water-Softening Plant Would Produce Savings.

Summary of Problem III.

(1) If a railroad runs through a region where hard water is the cause of trouble and expense, it would undoubtedly benefit that railroad to install water-softening plants. The actual benefits obtained from water-softening plants by the five railroad companies referred to under Problem II are evidence of this.

(2) If a railroad has increased the size of its locomotives and found that it has more boiler troubles due to hard water than it had with the smaller locomotives, it would be a benefit to install water-softening plants.

(3) It may be a benefit to soften any water used in locomotive boilers that contains 7 or more grains per gallon of hardening matter, or even less than 7 grains, if the hardening matter consists largely of sulphate of lime.

(4) It would not be of much benefit to soften a water that contains 50 grains per gallon of alkali salts before treatment, and also a considerable quantity of sulphate of lime, by soda ash, for, although the water can be softened so that it will not make scale, yet it will cause trouble from foaming.

BUILDINGS.

The committee on buildings had recommended that the circular form is the modern type for a roundhouse. In view of the fact that rectangular roundhouses are being very extensively studied at the present time objections were raised to this definite recommendation, and the report was changed to eliminate this feature. There was some discussion on the heating of roundhouses. Mr. D. MacPherson, of the Canadian Pacific Ry., spoke of satisfactory experience with steam heating with partial vacuum. By pumping the air out of the pipes it is found practicable to heat the houses with a pressure of 1½ pounds of exhaust steam.

Mr. Garrett Davis, Chicago, Rock Island & Pacific Ry., has been using steam heat and found the cost of installation to be $75 per stall. Mr. Kelley, of the Minneapolis & St. Louis R. R., stated that he had found the cost of installing a hot air system to be $250 per stall, for a 15-stall roundhouse, and $150 per stall, for a 27-stall roundhouse.

The conclusions of the report of this committee are published herewith:

(2) Recommendation Relative to One General Waiting Room or Separate Waiting Rooms in Local Passenger Station, Without Reference to Separate Waiting Rooms for Colored People.

Your comittee recommends the use of one general waiting room for the following reasons:

(1) It allows the general waiting room to be properly proportioned.

(2) It permits proper development of a retiring room for women with private entrance to their toilet.

(3) It readily admits of the other rooms being properly proportioned.

(4) It allows ease of access from agent's office to the trains, to the baggage room and to the waiting room.

(5) It allows the ticket office to be used for a registering or an "O. S"ing office.

(6) It admits of the station being contracted in size without detriment of facilities.

(7) Economy in heating.

(8) It admits easily of varied treatment architecturally.

The committee therefore requests that the association approve the use of one general waiting room for a local passenger station, without reference to separate waiting rooms for colored people.

(3) Recommendations Relative to the Requirements of a Modern Roundhouse.

(1) That the form be circular and that the locomotives stand in the house normally, with the tender toward the turntable.

(2) That distance from center of turntable to the inner side of roundhouse shall be determined by the number of stalls required in the full circle.

That length of stall along center line of track should be not less than 85 feet in clear.

(3) That clear opening of entrance doors should be not less than 12 feet in width and 17 feet in height.

That the angle between adjacent tracks should be an even factor of 180 degrees, so that the tracks at the opposite ends of the turntable will "line up" with it.

(4) The turntable should be not less than 75 feet in length. The table should be operated by power, preferably electric.

(5) The material used in construction of the house should be non-corrosive, unless proper care be taken to prevent corrosion.

(6) Engine pits should be not less than 60 feet in length, with convex floor, and with drainage toward the turntable. The walls and floors may be of concrete, and proper provision should be made in construction for the support of the packing timbers.

(7) Roundhouse doors should roll or fold and be made of

non-corrosive material, unless the cause of corrosion be removed.

(8) Smokejacks should be fixed, having large hoods; constructed preferably of non-corrosive material and supplied with dampers. The cross section of the stack should be not less than 30 inches in diameter.

(9) The floor should be of vitrified paving brick laid flat on a concrete foundation and grouted. It should be crowned between pits, and that part adjacent to pits within jacking limits should be of wood.

(10) Drop pits should be furnished for handling truck wheels, driving wheels and tender wheels. These can be most economically constructed in pairs.

(11) The building should be heated with hot air by the indirect method, and the supply should be taken from the exterior of the building (no recirculation of air should be allowed). The air should be delivered to the pits under the engine portion of the locomotive.

Air ducts should be located under the floor and special pre caution should be taken to keep them dry.

(12) As much light should be obtained from the exterior of the building as good construction will allow.

(13) There should be an arc light, and a plug outlet for incandescent lights in each space between stalls.

(14) The contents of boilers should be taken care of and discharged outside of the building in a suitable receptacle and the heat units used as may be deemed best.

(15) Cold water should be supplied at each alternate space between stalls from an outlet not less than 2½ inches, located at a point about opposite front end of firebox; the water pressure should be not less than 80 pounds. The hydrants should be located below the floor in properly constructed pits amply drained.

Modern practice requires the use of hot water in the maintenance of boilers.

(16) Compressed air is used for mechanical hoisting and blowing operations. Overhead outlets should be furnished in each space between stalls opposite front end of firebox. The pressure should be from 80 to 100 pounds.

(17) A modern roundhouse should have facilities for the location of a few necessary machine tools, preferably electrically driven.

(18) Air hoists, or portable gooseneck cranes with differential blocks, on wheels, should be furnished for handling heavy repair parts.

(19) The turntable pit side walls should be of concrete with wooden coping not less than 6 inches thick, and the ties under the circular rail should be supported on concrete walls. Pivot masonry may be of concrete with stone cap.

The committee suggests that the association approve the above recommendations in regard to modern roundhouse requirements.

## MASONRY.

The committee on masonry had submitted a report on cement specifications by a joint committee representing the American Society of Civil Engineers, the American Society for Testing Materials, the American Institute of Architects, the Engineering Department of the United States' army, the Association of Portland Cement Manufacturers and the American Railway Engineering and Maintenance of Way Association. These specifications cover both natural and Portland cement, and it was voted to adopt them in toto, without any change. The following conclusions of this committee were then adopted:

### CONCLUSIONS.

That this association adopt as standard the "Standard Specifications for Cement" (both Portland and Natural) of the "joint committee," and in connection with the same the "Abstract of Methods Recommended by the Special Committee on Uniform Tests of Cement of the American Society of Civil Engineers," as published in this report.

Second.—Omitted for this year.

Third.—Under certain conditions the use of concrete backing for stone face work is desirable, and is considered good practice when economical.

Fourth.—Imbedding large stones in the interior of heavy concrete structures is accepted as good practice when a saving would result, and when the thickness of structure is not less than four feet.

Fifth.—Concrete, either plain or reinforced, is recommended for bridge seats and pedestal caps in place of limestone or sandstone.

Sixth.—That good practice permits the substituting of reinforced concrete for the common forms of construction for small openings.

## BALLAST.

The report of the committee on ballasting is published herewith. There were some minor changes from the report as presented last year, one of these relating to size in the specifications for stone ballast. We print these specifications in the revised form. The majority and minority of divisions of the committee had recommended ballast cross sections for three different classes of track. Owing to the fact that the committee had disagreed these sections were referred back to the committee for further consideration.

While there is a great variation in the qualities of the different natural materials for ballast, the choice of these qualities is not usually left to the engineer, but has been made already by nature, and all that is left to decide is what is most available or most expedient. This each one must decide for himself in the light of his own circumstances The question of finance may be a ruling consideration or there may be but one thing to be had, and he must take that or nothing.

In the case of crushed rock, however, the process of manufacture being under control, it is practicable to make the product conform to specifications.

### Specifications for Stone Ballast.

(1) Quality.—(a) Stone shall be durable enough to resist the disintegrating influences of the climate where it is used.

(b) It shall be hard enough to prevent pulverizing under the treatment to which it is subjected.

(c) It shall break in angular pieces when crushed.

(2.) Size.—(a) The maximum size of ballast shall not exceed pieces which will pass through a screen having 2-in. holes.

(b) The minimum size shall not pass through a screen having ¾-in. holes.

### Gravel.

Gravel should be screened or washed where prevention of dust is an object, but this need not be done where the character of traffic is such that dust is not particularly objectionable. It is recommended that gravel be screened or washed where the proportion of sand or clay exceeds fifty per cent. The minimum size should be such as is retained on screens of 12 meshes per inch. By this is meant the size pebble that would be retained in a thorough, careful test. The committee does not feel warranted in recommending any particular size or design of screen or arrangement of plant for screening gravel for the reason that it has not sufficient information on those points. It is hoped that some member of the association can throw some light on this phase of the gravel question.

### Cinders.

The use of cinders as ballast is recommended for the fol-

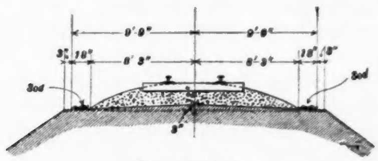
lowing situations: On branch lines with a light traffic; on sidings and yard tracks near point of production; as sub-ballast in wet, spongy places; in cuts and on fills; as sub-ballast on new work where dumps are settling, and at places where the track heaves from frost. It is recommended that provision be made for wetting down cinders immediately after being drawn.

Burnt Clay.

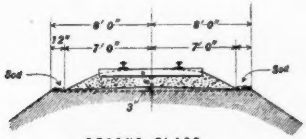
The material should be black gumbo or other suitable clay free from sand or silt. The suitability of the material should be determined by thorough testing in small test kilns before establishing a ballast kiln.

The material should be burned hard and thoroughly.

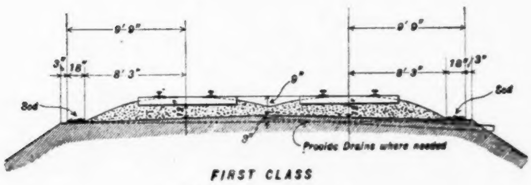
The fuel used must be fresh and clean enough to burn with



FIRST CLASS
Single Track, Cut or Fill



SECOND CLASS
Single Track, Cut or Fill



FIRST CLASS
Double Track, Cut or Fill

a clean fire. It is important that a sufficient supply be kept on hand to prevent interruption of the process of burning.

Burning should be done under the supervision of an experienced and competent burner.

Ballast should be allowed to cool before it is loaded out of the pit.

Absorption of water should not exceed fifteen per cent.

Ballast Cross-Sections.

At the joint meeting with the track committee, Nov. 29, ballast cross-sections for two classes of track were agreed upon, and these are shown as Fig. 1.

It was considered that a double-track road would hardly be other than first-class and consequently a double-track section is shown for first-class only.

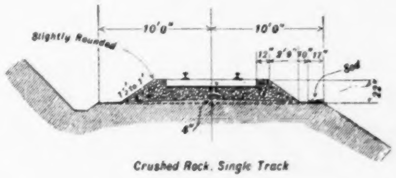
Oyster Shells.

As a matter which the committee thinks may be of interest to the members of the association, the following notes on oyster shell ballast, kindly furnished by Mr. F. L. Nicholson, engineer maintenance of way, Norfolk & Southern Railroad:

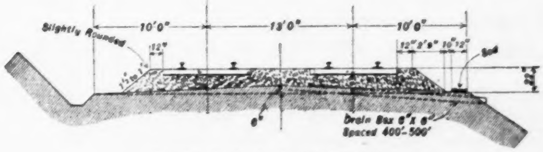
"We find that oyster shells are the best for our purpose; they are purchased from oyster packers in this section at prices ranging from 2½ to 3½ cents per bushel. As we have no special cars for handling ballast, they are loaded into gondolas and by opening the doors partially, they are distributed on the track while the train is in motion.

"The drainage properties are almost perfect, therefore the life of the tie is extended—how much we are unable to say at this time.

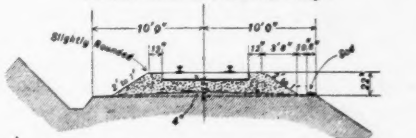
"There is an entire absence of dust. They somewhat reduce vegetation, but do not entirely prevent it. There is always more or less dirt mixed with the shells, and this with the lime will support life in certain kinds of weeds, and these have to be pulled out by hand. We now have about forty miles of track ballasted with oyster shells, and during the time we were ballasting there was on an average one high-

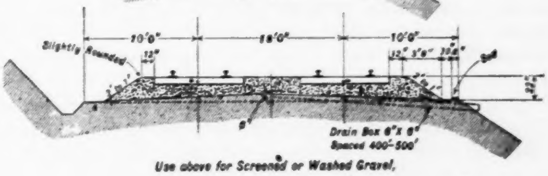


Crushed Rock. Single Track

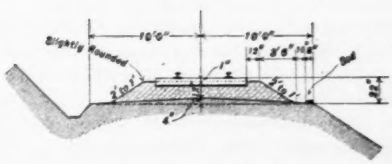


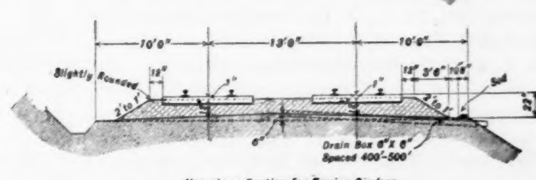
Use above Section for Crushed Rock, Slag



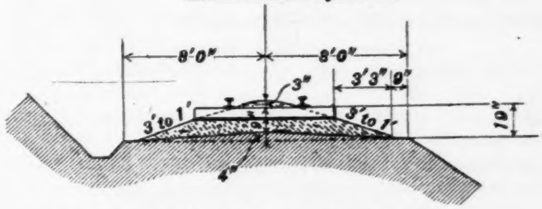


Use above for Screened or Washed Gravel,
Burnt Clay and Chats





Use above Section for Engine Cinders



Use above Section for Cementing Gravel,
Chert and Sand
Similar dressing for Earth

speed train per hour on this track. The following is table of particulars:

| Averages. | Oyster Shells. | Cost. |
|---|---|---|
| Bushels per mile | 42,266 | |
| Cubic yards per mile | 2,113.3 | |
| Cost of shells per bushel | | $ .0274 |
| Cost of shells per cubic yard | | .5480 |
| Cost of labor per cubic yard, shells | | .1744 |
| Cost per cubic yard in track | | .7224 |
| Cost per mile—labor | | 368.64 |
| Cost per mile—oyster shells | | 1,158.62 |
| Total cost per mile | | $1,527.26 |

"We paid our foremen at the rate of $42.00 per month and laborers $1.00 per day of ten hours."

Granulated Slag.

The committee also submits, as a matter of interest and information, the following notes on granulated slag prepared by Mr. Samuel Rockwell, assistant chief engineer, Lake Shore & Michigan Southern Railway:

"Slag naturally falls under two heads: First, that which is hard and vitreous and that will not slake, and, second, that which will slake, the latter being due principally to an excess of calcium and deficiency of magnesium oxides.

"Vitreous slag broken in sizes similar to broken stone makes fair ballast, but the lime slag is not good, as after slaking it sets into a solid mass almost resembling concrete.

"In order to facilitate and cheapen the handling of slag many furnaces are now making it into 'granulated slag.'

"The molten slag is run into a large cistern, and as it pours into it from the end of a trough it is met by a stream of water forced under pressure through a flat nozzle, and the action causes the slag to fly into fine particles somewhat resembling coarse sand. It is then dug out of the water with a clam-shell dredge.

"The product varies from sharp, hard and heavy, resulting from vitreous slag operated on with an excess of water, to soft, light and pummice-like, resulting both from too little water in the treatment, and from lime slag.

"The former kind makes an excellent ballast for yard work and on any tracks with moderate travel. It is easily worked and stays where it is put and has little dust. The soft kinds, however, should be avoided as they are liable to set, although to be sure, it will even then drain and do its full duty as ballast so long as it is not necessary to disturb it."

John V. Hanna, assistant engineer maintenance of way, St. Louis & San Francisco Railway, St. Louis, Mo. (chairman); C. A. Paquette, superintendent, C., C., C. & St. L. Ry., Indianapolis, Ind. (vice-chairman); C. H. Byers, division engineer, Kansas City Southern Ry., Pittsburg, Kan.; A. Q. Campbell, Hogansville, Ga.; L. F. Goodale, engineer maintenance of way, C., B. & Q. Railway, St. Louis, Mo.; G. D. Hicks, superintendent, N. C. & St. L. Ry., Tullahoma, Tenn.; B. C. Milner, superintendent, Southern Railway, Louisville, Ky.; J. O. Osgood, chief engineer, Cen. R. of N. J., Jersey City, N. J.; F. W. Ranno, engineer maintenance of way, Southern Indiana Railway, Terre Haute, Ind.; Samuel Rockwell, assistant chief engineer, L. S. & M. S. Ry., Cleveland, O.; J. G. Sullivan, division engineer, Can. Pac. Ry., Winnipeg, Manitoba, committee

MINORITY REPORT.

While the ballast cross-sections embodied in the above report were approved by the track and ballasting committee at the joint meeting, the undersigned members of the ballasting committee do not believe them to be the best for general adoption, and submit for the consideration of the association the sections shown as Figs. 2, 3 and 4.

Signed, John V. Hanna, C. H. Byers and L. F. Goodale.

TRACK.

The report submitted by the committee on track was the same as that presented last year with a few modifications. By vote of the convention the following part of the report referring to "maintenance of gage" and "inspection of track" was adopted and ordered printed in the Manual of Recommended Practice:

Maintenance of Gage.

(a) Proper Method of Spiking:

(1) The gage (tool) used shall be the standard gage recommended.

(2) When track is intended to be spiked to standard gage the rail shall be held against the gage with a bar while the spike is being driven.

(3) Within proper limits a slight variation of the gage from standard is not seriously objectionable, provided the variation is uniform and constant over long distances. Under ordinary conditions it is not necessary to regage such track when the increase in gage has not amounted to more than three-eighths of an inch.

(4) All the spikes shall be started vertically and square, and so driven that face of spike shall come in contact with base of rail; the spike should never have to be straightened while being driven.

(5) Outside spikes of both rails shall be on the same side of the tie, and the inside spikes on side opposite side of the tie. The inside and outside spikes shall be separated as far apart as the face and character of the tie will permit. The ordinary practice shall be to drive the spike 2½ inches from the outer edge of the tie. All old spike holes must be plugged.

Inspection of Track.

Except in case of roads of very light traffic, all main track shall be inspected each day by section gang or trackwalker.

Trackwalker shall be sent over that portion of the track not covered by section men during the day's work.

Trackwalker or patrol shall be sent out in case of storm, washouts, etc., and during the period when slides or falling stone, etc., are to be expected.

The trackwalker shall be provided with spike maul, spikes and proper signals.

His duties shall be to carefully inspect the track, roadway, fences, gates, bridges and culverts, and in general guard against all damage or danger to any railroad property.

In case of trouble he will place torpedoes and other danger signals a sufficient distance to protect trains and will notify proper officers from the nearest possible point.

Supervisor or roadmaster shall be required to go over the whole of their district on foot or on handcar at least once every month, making close inspection of all details.

Last year there was a long discussion on a definition for gauge track, and the matter was referred back for consideration this year. The definition submitted by the committee this year was as follows: "The distance between the intersections of the plane of the tops of the rails and the planes of the running sides of the heads of the rails." This definition, as adopted, was changed to read as follows: "The distance measured between the sides of rails, ⅝ inch below top of head."

The election of officers resulted as follows: President, Mr. H. G. Kelley, chief engineer, Minneapolis & St. Louis R. R.; vice-president, A. W. Johnson, general superintendent, New York, Chicago & St. Louis R. R.; secretary, L. C. Fritch, assistant general manager, Illinois Central R. R.; treasurer, W. S. Dawley, engineer maintenance of way, Chicago & Eastern Illinois R. R.; directors, J. B. Berry, chief engineer, Union Pacific R. R.; W. McNab, assistant engineer, Grand Trunk Ry. The convention adjourned at 5 p. m. on Thursday, March 23.

## *Exhibits at the Railway Engineering and Maintenance of Way Convention*

An unusually large exhibit of railway supplies was made this year in connection with the annual maintenance of way convention. Devices large and small were exhibited and the Auditorium parlor was crowded to overflowing with them. The following list is of the railway supply concerns and their representatives who exhibited:

Adams & Westlake Company, Chicago. Signal lamps, lanterns, switch locks and long time burners. Represented by W. J. Pierson.

Amalgamated Gravity Battery Plate Company, Philadelphia, Pa. Amalgamated gravity battery plates, a substitute for the copper element in these batteries. Represented by W. N. Gove and D. B. Raffner, Jr.

American Asphaltum & Rubber Company, Chicago. Samples of paint, bridge coating, ready roofing, waterproofing material. Represented by W. R. Lonsdale and Harry Fox.

American Ballast Company, Chicago. Samples of burnt clay ballast. Represented by S. B. Fleming and J. A. Washick.

American Standard Rail Joint Company, Bloomington, Ill. The American standard insulated rail joint. Represented by W. A. Freese and J. Gordon.

American Steel & Wire Company, Chicago. Right of way wire fences. Represented by J. M. Holloway and George P. Rider.

American Valve & Meter Company, Cincinnati, O. Economy switch-stands, rail point guard and safety switch point lock, water column and tank fixtures. Represented by N. Paul Fenner, Jr., J. T. McGarry and F. C. Anderson.

Armstrong Bros. Tool Company, Chicago, Ill. Universal ratchets, clawbars, etc. Represented by L. H. Webster.

Armstrong, S. A., Lindsay, Ontario, Canada. Two side sections of the "Nogo" cattleguard, steel slats and wood slats.

Atlas Railway Supply Company, Chicago. Joints, braces, tieplates and one switchstand. Represented by J. G. McMichael, C. Sulfer and G. M. Huber.

Barker Mail Crane Company, Clinton, Ia. One Barker mail crane, one Barker mail pouch catcher. Represented by L. W. Barker.

Beaver Dam Malleable Iron Company, Beaver Dam, Wis. Malleable iron tieplates, rail braces and the F. & N. antispreader and anti-creeper combined. Represented by D. P. Lamoreux, L. Fitch and A. Martin.

Belle City Malleable Iron Co., Racine, Wis. L. & S. anti-rail creeper and the extension rail brace. Represented by S. R. Bryan and S. W. Sponenburg.

Bird & Son, F. W., Chicago. Prepared roofings, waterproofing felts and insulating materials. Represented by J. J. Sullivan and A. R. McAlpine.

Border Bolt & Nut Lock Company, Richmond, Ind. Samples of nut locks. Represented by E. D. Findlay.

Brown Sphinx Company, Chicago, Ill. The R. L. Brown switchstand. Represented by R. L. Brown.

Buda Foundry & Manufacturing Company, Chicago, Ill. Paulus track drills, Buda track drills, Wilson track drills, switchstands, rail benders, car replacers, jacks, pressed steel switch clips, rail braces, compromise joints, insulated rods and Buda anti-friction metals. Represented by W. E. Marvel, T. M. Orr, W. H. Bloss and T. J. Hanahan, Jr.

Cambria Steel Company, Philadelphia, Pa. Samples of 100 per cent rail joints. Represented by A. Morrison, engineer.

Chicago Bridge & Iron Works, Chicago, Ill. Photographs of steel tanks for railway service. Represented by George Horton, K. L. Small and E. G. Ladd.

Chicago Steel Tape Company, Chicago, Ill. Steel measuring tapes and leveling rods. Represented by L. A. Nichols.

Chicago Wire Fence & Tool Company, Chicago. Chicago heavy fence stays and tools. Represented by E. F. Compton.

Cleveland Frog & Crossing Company, Cleveland, O. Represented by George C. Lucas and George Stanton.

Climax Stock Guard Company, Chicago. Sections of the Climax cattleguard. Represented by F. W. Stewart and F. V. Stewart.

Consolidated Cross Tie Company, New York. Railroad crossties made by the Hege machine and treated by the Giussani process. Represented by J. T. Collins.

Continuous Rail Joint Company of America, Newark, N. J. Represented by L. F. Braine, W. E. Clark, V. C. Armstrong and D. J. Evans.

Cortright Metal Roofing Company, Chicago. Samples of metal shingles as applied to roofs. Represented by H. A. Follette.

Coughlin-Sanford Switch Company, New York and Chicago. Working model of a swing rail frog and switch. Represented by P. Jones.

Dayton Hydraulic Machinery Company, Dayton, O. Brooks centrifugal pump in operation. Represented by Frederick Myers.

Detroit Graphite Manufacturing Company, Detroit, Mich. Represented by J. T. Dinkgrave.

Dickinson, Paul, Chicago. Model of a roundhouse equipped with cast iron vitribestos smokejacks, also cast iron ventilators and chimneys. Represented by Paul Dickinson, A. J. Felkins and J. H. Meaden.

Dilworth, Porter & Co., Limited, Pittsburg, Pa. Railroad and boat spikes and tie plates. Represented by C. Stein and W. F. Schleiter.

Dixon Crucible Co., Joseph, Jersey City, N. J., and Chicago, Ill. Samples of paint, lumber pencils, pencils, etc. Represented by E. R. Smith and H. F. Soden.

Doelp Forging & Castings Specialty Company, Lima, O. Doelp "Perfection" lock nut. Represented by G. H. Meily.

Dormant Sod Company, Chicago. Showing dry fertilizers and seeds in sheet form ready to be laid, also samples of same, showing different stages of growth of grass. Represented by D. E. Brink.

Eastern Granite Roofing Company, New York and Saint Louis. Samples of Eastern Granite Roofing. Represented by H. Henning, S. Reid Holland and Charles V. Eades.

Edison Manufacturing Company, New York. Primary batteries, plug spark wells, etc. Represented by H. J. Campbell and W. S. Logue.

Engineering Agency, Incorporated, Chicago. Represented by A. G. Frost.

Eyeless Tool Company, Newark, N. J. Picks and track tools. Represented by M. F. Wood.

Fairbanks, Morse & Co., Chicago, Ill. Automobile type motor inspection cars, Barrett jacks, Sheffield standpipes and track leveling device. Represented by W. H. Garrett, A. A. Taylor, C. W. Kelly, Newton Corbett, H. H. Clark, C. D. Walworth and E. M. Smith.

Gilchrist, Charles A., New York, N. Y. Full sized model of the Gilchrist rail joint. Represented by C. A. Gilchrist.

Goldie, Jr., Company, William, Bay City, Mich. Goldie perfect tie plugs. Represented by William Goldie, Jr.

Grip Nut Co., Chicago. Grip nut locks. Represented by D. O. Ward.

Hall Rail Joint Company, Chicago. Rail joints. Represented by C. F. Hall and Henry Kunz.

E. T. Harris, Chicago. Railroad velocipede (Red Cross folding). Represented by E. T. Harris.

Hart Steel Company, New York. Hart tieplates. Represented by H. H. Hart.

Hussey-Binns Shovel Company, Pittsburg, Pa. Shovels, spades and scoops. Represented by J. H. Martin.

Illinois Steel Company (cement department), Chicago, Ill. Pictures, samples of raw material and finished product of the universal Portland cement, also hollow building stone. Represented by E. F. Affleck and A. E. Robinson.

Independent Railroad Supply Company, Chicago. The Wolhaupter rail point and tieplate. Represented by Benjamin Wolhaupter and E. L. Van Dressar.

Ingersoll-Sergeant Drill Company, New York and Chicago. Hose coupling, chipping and riveting hammers, two H. D. stone drills. Represented by Joseph R. Best.

Jacques, W. R., Kansas City, Mo. Model of K. K. car blocker and derailer. Represented by W. R. Jacques.

Jordan Company, O. F., Chicago, Ill. Photographs of earth and ballast spreader. Represented by O. F. Jordan and A. I. Benedict.

Keuffel & Esser Company, New York. Engineering and surveying instruments. Represented by J. N. Gastfield and R. Link.

Leschen & Sons Rope Company, A., Saint Louis. Samples of wire rope, switch ropes, tackle blocks and wire rope fastenings. Represented by Charles Berninger, Jr.

Lidgerwood Manufacturing Company, New York. Photographs of hoisting engines, the Lidgerwood rapid unloader and apparatus for coaling vessels at sea. Represented by Walter H. Baldwin.

Link Belt Machinery Company, Chicago. Photographs of coal handling machinery. Represented by J. A. Werner.

Ludowici Roofing Tile Company, Chicago. Samples of roofing tiles. Represented by J. D. Duffy and Leroy Wallace.

Lufkin Rule Company, Saginaw, Mich. Measuring tapes, etc. Represented by Theodore Huss and W. D. Almy.

Macleod & Co., Walter, Cincinnati, O. Buckeye torchlights and Buckeye heater, photographs of railway labor saving devices. Represented by J. M. Brown.

Maloney Railroad Ditching Machine, Vincennes, Ind. Model of a ditching machine mounted on a flat car. Represented by D. H. Maloney.

McClintock Manufacturing Company, Saint Paul, Minn. Locomotive telegraph, telephone and automatic block signal system. Represented by Edward McClintock and G. E. Tripp.

Mann-McCann Company, Chicago. Models of roundhouse smoke jacks, roundhouse with electric lighting, McCann spreader and grader cars. Represented by O. C. Mann.

Merchant & Co., Incorporated, Philadelphia, Pa., and Chicago, Ill. Cast iron ventilator for roundhouse. Represented by H. J. Wixson.

Merrill-Stevens Manufacturing Company, Kalamazoo, Mich. Standard jacks and Cook's patent cattleguards. Represented by Eugene Cook.

Miller Anchor Company, Norwalk, O. Wrecking anchors and augers. Represented by G. H. Miller.

Morden Frog & Crossing Works, Chicago. Model switchstands and two full size stands. Represented by J. T. Harz and C. E. Dearborn.

Municipal Engineering & Contracting Company, Chicago. Models of Chicago improved cube concrete mixer. Represented by Ernest McCullough and T. M. Meek.

National Cattle Guard Company, Chicago. National surface guard No. 7, for oblique crossing. Represented by W. J. Hamlin.

National Lock Washer Company, Newark, N. J. Samples of nut locks. Represented by R. L. Thomas, J. B. Seymour and F. B. Buss.

National Roofing Company, Tonawanda, N. Y. Samples of Security brand mineral asphalt roofing. Represented by T. B. Lehon.

Nichols, George P., & Bro., Chicago, Ill. Illuminated photographs of transfer tables, turntables, tractors, drawbridge machinery, special appliances, derrick cars, etc. Represented by George P. Nichols.

Otto Gas Engine Company, Chicago. Photographs of coaling stations, railway water tanks, water cranes with metal flexible spouts, sand blast and pneumatic tool cars and water softening plant. Represented by C. C. Lazenby, T. W. Snow and W. H. Patton.

Pennsylvania Steel Company, Steelton, Pa. New Century switchstand and the New Century adjustable, long safety switchstand. Challenge adjustable switchbar, novel device for locking switch point for main line use and model of the anvil faced frog. Represented by M. W. Long, C. W. Reinoehl and R. E. Belknapp.

Railroad Supply Company, Chicago. Highway crossing alarms, signals and tieplates, Represented by G. A. Douglass, E. W. Vogel and E. H. Bell.

Railroad Appliances Company, Chicago, Ill. Q. & C. Bonzano rail joint, Q. & C. anti-creeper, Graham combined guardrail and frog brace, American guardrail fastener and catalogue of the Oldsmobile railroad inspection car. Represented by F. C. Arey, S. J. Collins, E. M. Smith, G. T. Briggs and F. C. Webb.

Ramapo Iron Works, Hillburn, N. Y. Ramapo automatic switchstand attached to a Fairbanks scale, showing pressure of point against stock rail, McPherson switch and frog. Represented by Arthur Gemunder, W. B. Lee and W. C. Kidd.

Rand Drill Company, Chicago and New York. Photographs and catalogues of air compressors and various kinds of Imperial pneumatic tools. Represented by W. H. Traver.

Roberts Car & Wheel Company, Three Rivers, Mich. Pressed steel gallows frame for hand cars, also pressed steel wheels. Represented by M. Mowbray.

Robertson Manufacturing Company, Chicago. Blueprints and photographs Robertson ash conveyer. Represented by J. W. Bryce.

Rodger Ballast Car Company, Chicago, Ill. Photographs of the Hart convertible and Rodger ballast cars. Represented by H. S. Hart.

Safety Nut Lock Company, Minneapolis, Minn. Samples of nut locks. Represented by De Witt Nelson and R. C. Brewsaugh.

Saint Louis Expanded Metal & Fireproofing Company, Saint Louis, Mo. Old and new sections of corrugated bars for reinforcing concrete, varying in size from 1/4 inch to 1 1/4 inches. Represented by T. L. Condron.

Scherzer Rolling Lift Bridge Company, Chicago. Photographs of Scherzer rolling lift bridges. Represented by F. F. Soule and George T. Van den Berg.

Scott Manufacturing Company, Racine, Wis. The Racine rail anchor. Represented by J. M. Scott and Willard Walker.

Seelig, R., Chicago, Ill. Engineering and surveying instruments. Represented by E. Seelig.

Slaymaker, S. R., Lancaster, Pa. Switch locks and padlocks. Represented by J. M. Brown.

Solid Steel Tool & Forge Company, Pittsburg, Pa. Represented by George Ackerman.

Spencer, Otis Company, Chicago. Hart tieplates and photographs of National coal dump car. Represented by Spencer Otis, W. L. De Remer and H. H. Hart.

Stowell Manufacturing & Foundry Company, South Milwaukee, Wis. Sliding door hangers for freight houses, cars, etc. Represented by R. A Nourse and R. T. Brady.

Strauss, J. B., Chicago, Ill. Model of the Strauss trunnion bascule bridge and ribbed concrete steel bridge. Represented by J. B. Strauss.

Trussed Concrete Steel Company, Detroit, Mich. Kahn system of concrete reinforcement. Represented by Robert A. Travers.

U. S. Metal & Manufacturing Company, New York City. "Perfect" pressed steel and "Victor" cast steel car replacers for use on steam and electric railways. Represented by B. A. Hegeman, Jr., and F. C. Durham.

U. S. Steel Piling Company, Chicago, Ill. Models of U. S. steel sheet piling. Represented by H. Stabell.

Variety Manufacturing Company, Chicago. Cross horizontal folding door. Cross double slide-up door. Represented by Walter H. Barry.

Verona Tool Works, Pittsburg, Pa. Represented by W. D. Hechler and Orlando Metcalf, Jr.

Walters & Okell, Fort Madison, Ia. Model of Walters ballast placing device. Represented by C. L. Okell.

Weber Railway Joint Manufacturing Company, The, New York and Chicago. Represented by J. C. Barr, F. P. Thompson, F. A. Poor, H. C. Holloway, W. T. Smetten, G. A. Hagar and A. T. Herr.

Whall & Co., C. H., Boston, Mass. Fiber insulating and railroad specialties. Represented by F. R. Whall.

Wharton, Jr., Wm., & Co., Incorporated, Philadelphia, Pa. Manganese steel frogs and photographs of manganese frogs, crossings, Wharton U. M. L. switch, Wharton derailers, etc. Represented by Arthur S. Partridge, of Saint Louis.

## *Personals*

Mr. W. W. Wicker has been appointed roadmaster of the Denver, Enid & Gulf at Enid, Okla.

Mr. P. A. Bivins, engineer in charge of the Toledo & Indiana, at Toledo, O., has been appointed assistant to Chief Engineer Newhall, of the Wabash, with office at Toledo.

Mr. R. C. Sattley, formerly foreman of bridges and buildings of the Chicago & Northwestern at Chicago, has been appointed division engineer at Winona, Minn., to succeed Mr. Willard Beaham, resigned.

Mr. Francis L. Stuart has resigned as engineer of surveys of the Baltimore & Ohio to accept the position of chief engineer of the Erie with headquarters at New York, vice Mr. W. L. Derr, acting chief engineer, who has been appointed acting superintendent of the Susquehanna division.

Mr. J. L. Crider has resigned as assistant engineer of the Baltimore & Ohio at Hazelwood, Pa., to accept a position in New York.

Mr. J. O. Potts, inspector of maintenance of the Baltimore & Ohio, has resigned to accept a position with the Missouri Pacific.

Mr. Harry R. Talcott, assistant engineer of the Baltimore & Ohio, at Cumberland, Md., has been appointed engineer of surveys, with headquarters at Baltimore, Md., to succeed Mr. F. L. Stuart, resigned.

Mr. Willard Beahan, formerly division engineer of the Chicago & Northwestern at Winona, Minn., has been appointed principal assistant engineer of the Lake Shore & Michigan Southern, with headquarters at Cleveland, O.

Mr. A. B. Manning, superintendent of bridges and buildings of the Missouri, Kansas & Texas at Denison, Tex., died on February 19, of typhoid fever, aged 52 years.

Mr. L. C. Fritch has been appointed assistant to the general manager of the Illinois Central, with headquarters at Chicago.

Mr. H. B. Stoner has resigned as assistant engineer of the Northern Pacific to become chief engineer of the Spokane Valley Land & Water Co. at Spokane, Wash.

Mr. J. H. Hadley, formerly roadmaster of the Missouri Pacific at Independence, Kan., has been appointed division engineer of the St. Louis, Iron Mountain & Southern at Little Rock, Ark.

Mr. W. W. Vail, who recently resigned as chief engineer of the Gulf & Ship Island, has accepted a position as engineer with the firm of Hodges & Mimms, railroad contractors, Birmingham, Ala.

Mr. J. Francis Le Baron has been appointed chief engineer of the Louisville, Cumberland & Chattanooga.

Mr. Fred Lavis has been appointed resident engineer of the New York, Westchester & Boston at Mount Vernon, N. Y.

Mr. B. B. Stakemiller has been appointed engineer of maintenance of way of the Illinois Terminal Railroad, with headquarters at Alton, Ill.

Mr. W. W. Polk has been appointed assistant engineer of the railway division of the Maryland, Delaware & Virginia Railway at Lone Point, Md.

Mr. J. J. Hess has been appointed general roadmaster of the St. Louis Southwestern of Texas at Mt. Pleasant, Tex., to succeed Mr. P. O'Donnell resigned.

Mr. H. Rettinghouse, formerly foreman of bridges and buildings of the Chicago & Northwestern at Kankanna, Wis., has been appointed division engineer of the Wisconsin Central at Fond du Lac, Wis.

Mr. R. P. Johnson has been appointed resident engineer in charge of electrification of the New York Central & Hudson River R. R. in the zone south of Croton and North White Plains, N. Y., with headquarters at New York City.

Mr. C. L. Cruger has been appointed resident engineer of the Louisville & Nashville at La Follette, Tenn. He was formerly chief clerk to Mr. J. E. Willoughby, chief engineer of construction at Knoxville, Tenn.

Mr. George F. Morse has resigned as chief engineer of the Missouri, Oklahoma & Gulf.

Mr. William Merrit has been appointed roadmaster of the Manistee & Grand Rapids at Filer City, Mich.

Mr. F. L. C. Bond has been appointed resident engineer of the eastern division of the Grand Trunk, at Montreal, Quebec.

Mr. H. E. Newcomet, engineer maintenance of way of the Southwest system of the Pennsylvania Lines at Cincinnati, O., has been appointed engineer maintenance of way of the Erie & Ashtabula division of the Northwest system, with headquarters at New Castle, Pa., vice Mr. H. E. Culberston, who has been transferred to the Cleveland & Pittsburgh division at Wellsville, O., in a similar capacity.

Mr. William Jennings, who was civil engineer on the Hocking Valley during the construction of that road, died on March 16 at Columbus, O., aged 63 years.

Mr. Alexander C. Shand, engineer maintenance of way of the Pennsylvania at Philadelphia, Pa., has been appointed assistant chief engineer. Mr. L. R. Zollinger, principal assistant engineer of the Pennsylvania Railroad division at Altoona, Pa., has been appointed engineer maintenance of way in place of Mr. Shand. Mr. A. J. Whitney, Jr., assistant engineer of the Cape May division of the West Jersey & Seashore at Camden, N. J., has been appointed principal assistant engineer of the Pennsylvania Railroad division, to succeed Mr. Zollinger. Mr. J. H. Gumbes, assistant engineer of the Monongahela division, has been appointed to succeed Mr. Whitney on the West Jersey & Seashore. Mr. A. B. Cuthbert, assistant engineer of the Elmira & Canandaigua division of the Northern Central, has been transferred to Pittsburgh, Pa., as assistant engineer of the Monongahela division, in place of Mr. Gumbes. Mr. Walter Thompson has been appointed

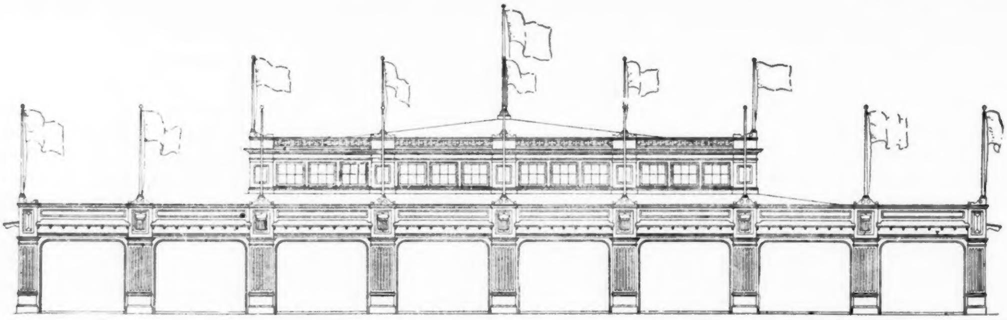


FIG. 1—ELEVATION AMERICAN RAILWAY APPLIANCE EXPOSITION BUILDING, WASHINGTON, D. C.

assistant engineer at Elmira, N. Y., succeeding Mr. Cuthbert.

Mr. H. U. Wallace has resigned as chief engineer of the Illinois Central to accept the position of manager of the contracting firm of Thomas Phee & Co., with headquarters in the Grand Central Station, Chicago. Mr. A. S. Baldwin, heretofore engineer of construction, has been appointed chief engineer to succeed Mr. Wallace, and the office of engineer of construction is abolished, effective on March 20. Mr. H. R. Safford, heretofore principal assistant engineer, has been appointed assistant chief engineer in charge of maintenance. Headquarters, Chicago. Mr. Wallace is a son of Mr. J. F. Wallace, late general manager of the Illinois Central and now chief engineer of the Panama Canal and has been in the service of the Illinois Central since 1888. He held various minor positions in the engineering department until January 1, 1894, from which date to September 30, 1896, he was assistant engineer. He was then roadmaster of the Chicago terminals until February, 20, 1898, and was roadmaster of the Louisville division from the latter date until March 20, 1900, when he was appointed assistant superintendent of that division. He was transferred to the superintendency of the Freeport division on April 1, 1900, and was made superintendent of the Louisville division on April 15, 1901. He was again transferred to the Freeport division on June 1, 1902, where he remained until he was appointed chief engineer, on September 23 of the same year. Mr. Baldwin was formerly for a number of years roadmaster of the Louisville & Nashville, and left that road in October, 1901, to accept the position of principal assistant engineer of the Illinois Central. He was made engineer of construction of the latter in May, 1903.

## *The American Railway Appliance Exhibition*

In the accompanying illustrations are shown the plan of the exhibit grounds, the elevation and the floor plan of the main exhibit building of the railway appliance exhibition which is to be held at Washington in connection with the International Railway Congress. The site of the exhibition is on the Washington monument grounds, in accordance with the special act of Congress. The main entrance to the grounds will be at Fifteenth street, where an imposing gateway is already erected, and the entrances at Fourteenth and Sixteenth streets. The main exhibit building, which is being erected to accommodate the smaller exhibits, is located at the Sixteenth street end. This building will be 160 by 200 feet and divided as shown in accompanying floor plan. The doorways are 12 feet high and may be closed in stormy weather by canvas curtains.

In the entire exhibit grounds there is something over 200,000 square feet, and it is evident from the applications already in that the space will be more than taken, one exhibitor alone having applied for 100,000 square feet, and another for between 4,000 and 5,000 square feet. Section B, Stall 14, will be the headquarters of Railway Engineering and Maintenance of way.

Mr. George A. Past, 160 Broadway, New York City, chairman of the general committee of arrangements, will gladly furnish any interested with full information regarding exhibit space, etc.

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The April issue of Graphite has a large number of illustrations of notable bridges and buildings in different parts of the world. It also has seasonable talks on good paint and good painting. A copy of this publication may be obtained free of charge by writing to the Joseph Dixon Crucible Co., Jersey City, N. J.

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In Japan there were, in 1902 and 1903, 9 government schools, 795 public schools (that is to say, supported by local authorities), and 51 private establishments, besides 3 institutes established by the government for the training of technical teachers. The Japanese, however, have long recognized that schools, colleges, and universities are not the only—indeed, are not the chief—means of educating men who will be useful in advancing the welfare of their country, and they have been in the habit of sending their best men—students, professors, manufacturers and merchants—to the various countries of the world for the purpose of enlarging their experience.

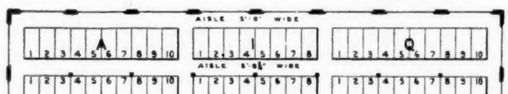

FIG. 3—FLOOR PLAN MAIN EXHIBIT BUILDING.

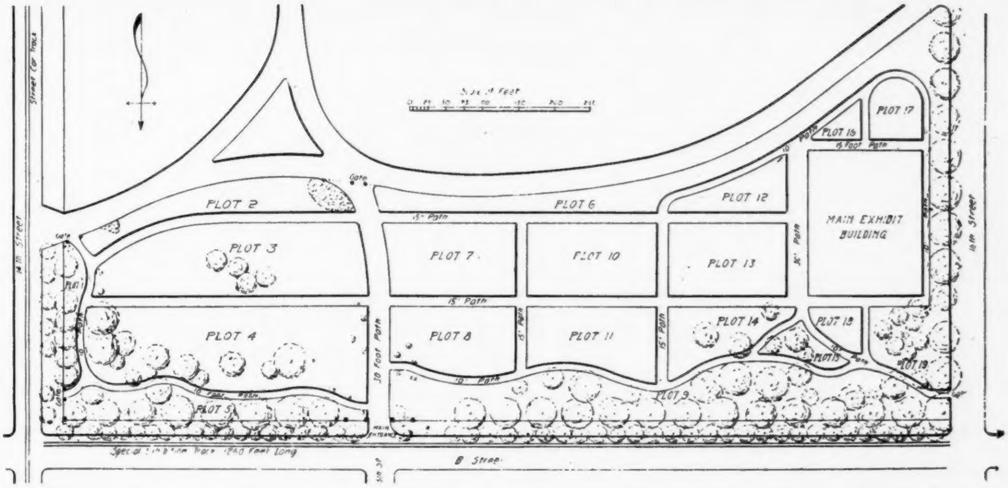


FIG. 2—GROUND PLAN AMERICAN RAILWAY APPLIANCE EXPOSITION, WASHINGTON, D. C.

# The Railway Engineering Index

**Of all important articles published during the previous month. The publisher of the Railway Engineering and Maintenance of Way will supply at the prices given at the end of the index, any of the articles referred to in the index.**

## BRIDGES.

..SCHERZER ROLLING LIFT BRIDGE OVER SWALE RIVER ENGLAND. Description; 600 words. Railway Review, March 18, 1905.

REPAIRING A BRIDGE PIER FOUNDATION ON THE BURLINGTON. 600 words, 2 illustrations. Railroad Gazette, March 17, 1905.

STANDARD BRIDGE ON THE HARRIMAN LINES. 5.900 words, 10 illustrations. Railroad Gazette, March 17, 1905.

BRIDGE LAUNCHING. By B. J. Forrest. Deals with erection, hauling and closing up trusses, etc., of bridges; 900 words, 1 illustration. Page's Weekly, March 10, 1905.

NOTABLE BRIDGE AND BUILDINGS. Illustration of a number never illustrated before; 11 illustrations. Graphite, April, 1905.

BRIDGE ERECTION BY LAUNCHING. Description of process of erection of bridges by launching; 1,000 words, 2 illustrations. Railway Review, March 11, 1905.

THE ANATOMY OF BRIDGEWORK VI. By W. H. Thorpe. Sixth article dealing with deformations; 2,700 words, 6 illustrations. Engineering, March 3, 1905.

THE ANATOMY OF BRIDGE WORK. V. By W. H. Thorpe. One of a series of articles dealing with high stresses; 2,700 words, 7 illustrations, 1 table. Engineering, Feb. 10, 1905.

THE AMSTERDAM AND HARLEM ELECTRIC LIGHT RAILWAY. Description of the Scherzer bridge over the Kostverloren Vaart; 1,200 words, 7 illustrations. Engineering, Feb. 3, 1905.

DR. STANTON'S RESEARCHES ON WIND PRESSURE. Communication; 200 words, 1 illustration, 1 table. Engineering, Feb. 24, 1905.

WIND PRESSURE ON BRIDGES. Discussion of probable wind pressure involved in the wreck of the high bridge over the Mississippi river at St. Paul; 2,800 words. American Society of Civil Engineers, February, 1905.

DISCUSSION OF A RATIONAL FORM OF STIFFENED SUSPENSION BRIDGE. 3,100 words, 2 tables. American Society of Civil Engineers, February, 1905.

BRIDGE OFFICE DRAFTING RULES. By H. C. Tyrrell; 6,000 words. Engineering News, March 23, 1905.

STANDARD-CODE RULES. By H. W. Forman. Continuation on should there be a revision of those for single track. 6,000 words. Railroad Gazette, March 10, 1905.

THE ERECTION OF THE KENTUCKY RIVER VIADUCT IN 1877. By Joseph H. Springer. The methods adopted in the erection; 2,300 words, 10 illustrations. Engineering News, March 23, 1905.

NEW CONCRETE ARCHES ON THE LAKE SHORE & MICHIGAN SOUTHERN RAILWAY. Description; 1,200 words, 8 illustrations. Railway Age, March 24, 1905.

CONNECTICUT AVENUE BRIDGE, WASHINGTON, D. C. Description; 1,100 words, 9 illustrations. Railway Age, March 24, 1905.

STANDARD BRIDGES ON THE HARRIMAN LINES. Description; 250 words, 8 illustrations. Railroad Gazette, March 24, 1905.

POWER HOUSE OF THE INDIANAPOLIS & CINCINNATI TRACTION COMPANY. Description of single phase power house; 13 illustrations; 3,200 words. Street Railway Journal, March 18, 1905.

NEW ANGUS SHOPS, CANADIAN PACIFIC RY. Continuation of previous articles. Power Distribution, Machines and Machine Arrangement; 11 illustrations; 4.000 words. Railway Review, March 4, 1905.

NEW ROUNDHOUSE AT ELKHART. Description of interior arrangements; 11 illustrations: 2,600 words. American Engineer, March, 1905.

NEW WHEEL FOUNDRY OF THE PENNSYLVANIA AT ALTOONA. Description of foundry; 10 illustrations; 4,100 words. Railroad Gazette, March 17, 1905.

LOCOMOTIVE REPAIR SHOPS OF THE PERE MARQUETTE. Description; 19 illustrations; 6,000 words. Railway Age, March 24, 1905.

SYSTEMS OF ELECTRICAL DISTRIBUTION. By J. Henry Klinck. Description of electrical distribution in shops; 6 illustrations; 4,200 words. Railway Master Mechanic, April, 1905.

NEW ANGUS SHOPS, CANADIAN PACIFIC RAILWAY. First article describing shops; 7 illustrations; 1,000 words. Railway Master Mechanic, April, 1905.

## BUILDINGS.

RAILROAD GARDENING. By A. Reinisch; 1.700 words, 2 illustrations. Railroad Gazette, March 17, 1905.

REMODELED PASSENGER STATION AT LA CROSSE, WIS. Description of the remodeled station of the C., M. & St. P. Ry. at La Crosse; 5 illustrations, 750 words. Railway Review, March 11, 1905.

NEW STATION OF THE READING AT HARRISBURG. Description; 1 illustration, 200 words. Railroad Gazette, March 10, 1905.

HOUSE DRAINAGE. By Gerard J. S. Jensen. First article dealing with sewer traps; 11 illustrations, 2,600 words. Engineering Review, March, 1905.

SANITARY BETTERMENT IN LARGE INDUSTRIAL PLANTS. By G. Burrage; 16 illustrations, 5,500 words. Journal of the Western Society of Engineers, Feby., 1905.

NEW DATA ON THE WEIGHT OF A CROWD OF PEOPLE. 10 illustrations, 2,100 words. Association of Engineering Societies, January, 1905.

REINFORCED CONCRETE MEDICAL LABORATORY. Brooklyn Navy Yard. Description of building; 19 illustrations, 1,300 words. Engineering News, March 23, 1905.

TEST OF AN INDIRECT HEATER COIL. By S. C. Root. Amount of steam condensed in an indirect coil under varying conditions of air velocity, temperature of entering air and depth of coil 8 curves; 1 illustration, 1 table, 1,900 words. Association of Engineering Societies, February, 1905.

PROTECTING STEEL STRUCTURES. Description of a number of tests with results in painting steel work; 1 illustration, 1 table, 1,500 words. Railway Age, March 24, 1905.

## TRACK.

BLOCK SIGNALING ON SINGLE TRACK. Communication on the different orders in handling trains on single track road; 700

# The Railway Engineering Index

words. Railway Age, March 3, 1905.

RAIL CREEPING. INVESTIGATION OF CAUSES, ETC. 4 tables, 5 illustrations, 11,900 words. Railway Review, March 18, 1905.

ROADBED IMPROVEMENTS ON THE SOUTHERN PACIFIC ROAD. 5 illustrations, 600 words. Railway Review, March 18, 1905.

A METHOD FOR STANDARDIZING MAINTENANCE OF WAY FORCES. By H. W. Church. 1 table, 2,600 words. Railway Review, March 18, 1905.

MANGANESE STEEL RAILS IN THE BOSTON ELEVATED. 7 illustrations, 1,250 words. Railroad Gazette, March 17, 1905.

A SIMPLE EASEMENT CURVE. By Paul Sterling. 1 illustration, 850 words. Railroad Gazette, March 17, 1905.

THE CANADIAN NORTHERN RAILWAY IN THE WEST. By R. D. Wilson. 6 illustrations, 2,400 words. Railroad Gazette, March 17, 1905.

IMPROVEMENT ON THE NEW YORK, NEW HAVEN & HARTFORD. 6 illustrations, 4,200 words. Railroad Gazette, March 17, 1905.

PROPOSED HIGH SPEED DOUBLE TRACK LINE FROM PATERSON TO NEW YORK. 1 illustration, 600 words. Railroad Gazette, March 17, 1905.

THE PENNSYLVANIA FREIGHT TERMINALS IN NEW YORK. Description; 7 illustrations, 3,600 words. Railroad Gazette, March 17, 1905.

THE DENVER, NORTHWESTERN & PACIFIC ROAD. Description of road; 7 illustrations, 2,400 words. Railroad Gazette, March 17, 1905.

REBUILDING THE O. R. & N. Description of improvements on the Oregon Railroad & Navigation Co.; 8 illustrations, 1,000 words. Railroad Gazette, March 17, 1905.

IMPROVEMENT ON THE CLEVELAND DIVISION OF THE B. & O. Description of the rebuilding and straightening line; 25 illustrations, 2,400 words. Railroad Gazette, March 17, 1905.

TRACK CIRCUIT CONTROL OF INTERLOCKING POWER DISTANT SIGNALS. Description; 1 illustration, 950 words. Railway Age, March 17, 1905.

THE CREEPING OF RAILS. Description of a German auto rail creeper; 1 illustration, 300 words. Railway Age, March 17, 1905.

THEORY AND PRACTICE OF SINGLE TRACK BLOCKING. By H. D. Emerson. 6,500 words. Railway Review, March 11, 1905.

THE EAST BOSTON TUNNEL OF THE BOSTON SUBWAY SYSTEM. A brief resume of the more important engineering features, 1,000 words. Railway Machinery, March 1905.

METAL FOR RAILS. By P. H. Dudley. Manufacture and inspection, rolling and straightening, acid tests of the section and structure of the steel, photo-micrographs and best metals to use; 12 illustrations, 4,400 words. Railway Age, March 10, 1905.

RAILS FOR LINES WITH FAST TRAINS. By P. H. Dudley. Continuation of article, 1,700 words. Railroad Gazette, March, 1905.

RAILROAD SIGNALING. Description of various systems used. 1,420 words. New England Railroad Club, February, 1905.

AUTOMATIC SIGNALING ON THE METROPOLITAN DISTRICT RAILWAY. Description of system; 1 illustration, 1,500 words. Engineering Review, March, 1905.

CHESTER & HOLYOKE RAILWAY. River Du Encroachments at Holywell; 3 illustrations, 510 words. Engineering Review, March, 1905.

THE SIMPLON TUNNEL. Description of tunnel; 6 illustrations, 3,400 words. Engineering, February 24, 1905.

WEAK TRACK AND DERAILMENTS. Communication on the strength of road bed in proportion to their loads; 1,200 words. Railway Age, March 3, 1905.

THE EAST BOSTON TUNNEL OF THE BOSTON SUBWAY SYSTEM. Description of construction; 2 illustrations, 1,100 words. The Contractor, March, 1905.

AUTOMATIC SIGNALING ARRANGEMENTS ON THE DISTRICT RAILWAY. Description; 3 illustrations, 2,100 words. Page's Weekly, February 24, 1905.

RAILROAD LOCATION. Discussion of Methods of Location on the Choctaw, Oklahoma & Gulf Railroad; 1 table, 4,600 words. American Society of Civil Engineers, February, 1905.

RAILROAD TERMINAL AT WASHINGTON, D. C. Description; 26 illustrations, 8,300 words. Railway Review, March 18, 1905.

THE GREENVILLE YARDS AND TRANSFER ARRANGEMENTS OF THE PENNSYLVANIA RAILROAD. Description; 18 illustrations, 2,400 words. Railway Age, March 24, 1905.

TRACK ELEVATION OF THE CHICAGO & WESTERN INDIANA THROUGH THE CITY OF CHICAGO. Description; 18 illustrations, 3,300 words. Railway Age, March 24, 1905.

NEW INTERLOCKING ON THE SOUTHERN. Description of manual block system; 5 illustrations, 600 words. Railroad Gazette, March 24, 1905.

NEW D., L. & W. TERMINAL AT HOBOKEN. Description; 3 illustrations, 500 words. Railroad Gazette, March 24, 1905.

### MISCELLANEOUS.

A MENACE TO THE NEW YORK HARBOR ENTRANCE. By L. M. Haupt. Conditions which fill up the harbor; 2 tables, 1 illustration, 4,700 words. The Journal of the Franklin Institute, February, 1905.

RECENT WORK OF UNIFYING SPECIFICATIONS FOR ENGINEERING MATERIALS. By J. P. Snow. Discussion of the best practice in the use of structural materials for standardization, 1,000 words. Association of Engineering Societies, January, 1905.

REPORT OF SUB-COMMITTEE ON CONCRETE AND REINFORCED CONCRETE. 6,200 words. American Society of Civil Engineers, February, 1905.

THE COMPENSATING WORKS OF THE LAKE SUPERIOR POWER COMPANY. By G. F. Stickney. Description of the works for regulating the amount of water flowing out of Lake Superior; 19 illustrations, 7,000 words. American Society of Civil Engineers, February, 1905.

MAXIMUM RAINFALL AT BOSTON. Discussion of Maximum rates; 1 table, 300 words. American Society of Civil Engineers, February, 1905.

THE RECLAMATION OF RIVER DELTAS AND SALT MARSHES. Discussion by J. L. J. Le Conte; 1 illustration, 700 words. American Society of Civil Engineers, February, 1905.

CONSTRUCTION OF PART OF THE INTERCEPTING SEWERS OF CHICAGO. By W. A. Shaw. Description; 13 illustrations, 13,200 words. Journal of the Western Society of Engineers, February, 1905.

THE COMMERCIAL ASPECT OF ENGINEERING. By C. A. S. Howlett. 7,500 words. Journal of the Western Society of Engineers, February, 1905.

DEEP BOREHOLE SURVEYING. Description of two sets of instruments used; 17 illustrations, 1,000 words. Page's Weekly, February 17, 1905.

THE UTILITY OF THE TRACTION DITCHER. Describing uses to which the ditcher may be put; 2 illustrations, 1,200 words. The Contractor, March, 1905.

HORNSTEIN'S TACHEOMETER. Description; 5 illustrations, 1 table, 700 words. Engineering, February 10, 1905.

FLOATING DOCKS. Discussion of the various types; 1,600 words. Engineering Review, March, 1905.

TELEPHONE LINE ENGINEERING. By C. J. H. Woodbury. Description of telephone line construction in overhead and underground work; 11,200 words. Journal of the Franklin Institute, March, 1905.

CONCRETE AND IMBEDDED METAL. By J. F. Wallace. The use of concrete strengthened by use of imbedded metal. Comparison of costs of bridges; 1 illustration, 800 words. Railway Age, March 17, 1905.

SPECIAL LADDER EXCAVATOR. Description of the excavator; 1 illustration, 250 words. Page's Weekly, March 10, 1905.

SAND PUMP DREDGING ON THE MERSEY. First article on the description of dredging; 7 illustrations, 1 table, 3,700 words. Engineering, March 10, 1905.

REINFORCED CONCRETE TUNNEL ON THE SOUTHERN. Description of tunnel and the process of making; 6 illustrations, 650 words. Railroad Gazette, March 17, 1905.

THE EFFECT OF OIL ON PORTLAND CEMENT CONCRETE. 5 illustrations, 3 tables, 3,500 words. Railroad Gazette, March 17, 1905.

SHEET PILE AND CANVAS COFFERDAM FOR A LARGE CONCRETE PIER. 11 illustrations, 1,400 words. Railroad Gazette, March 17, 1905.

REPORT ON AND PROCESS VIEWS OF THE PANAMA CANAL. 16 illustrations, 7,000 words. Railway Review, March 18, 1905.

DISINTEGRATION OF CEMENT BRIQUETTES BY OIL. By J. C. Hain. 11 illustrations, 3 tables, 3,400 words. Railway Review, March 18, 1905.

CONCRETE AND IMBEDDED METAL. By Serge De Kareischa. Russian and East China Railways. The use of concrete strengthened by the use of imbedded metal in railway work. Comparison, from the point of view of cost, of bridges of concrete strengthened by the use of imbedded metal, with those of metal. 2,000 words. Bulletin of the International Railway Congress, February, 1905 (2nd part).

CONCRETE AND IMBEDDED METAL FOR AMERICA. By J. F. Wallace. The use of concrete strengthened by the use of imbedded metal in railway works. Comparison, from the point of view of cost, of bridges of concrete strengthened by the use of imbedded metal. 9 tables, 65 illustrations, 20,000 words. Bulletin of the International Railway Congress, February, 1905.

CONCRETE AND IMBEDDED METAL—ALL COUNTRIES EXCEPT RUSSIA AND AMERICA. By W. Ast. The use of concrete strengthened by the use of imbedded metal in railway work. Comparison, from the point of view of cost, of bridges of concrete strengthened by the use of imbedded metal. 100 illustrations, 2,500 words. Bulletin of the International Railway Congress, February, 1905.

THE BALTIC STAMP MILL: LAKE SUPERIOR COPPER REGION. Description of plant for handling rock directly from the mine. 7 illustrations, 2,500 words. Engineering News, March 23, 1905.

RIVER DISCHARGE, MEAN VELOCITY, AND